Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LXI. NOVEMBER, 1921 No. 5

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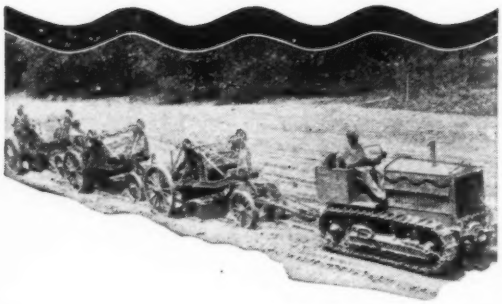
Price: Single copy 25 cents. Annual subscription in U. S. $2.00; Canada, $2.40; Foreign, $2.75.

MUNICIPAL AND COUNTY ENGINEERING is published monthly by Engineering Publishing Company, 702 Wulsin Building, INDIANAPOLIS, INDIANA, A. P. Fox, President, J. H. Pritchard, Secretary.

Changes of address, subscriptions and remittances should be addressed to MUNICIPAL AND COUNTY ENGINEERING, Indianapolis, Indiana. Editorial and business communications should also be addressed to 702 Wulsin Bldg., Indianapolis, Ind.

Editorial and Advertising Offices also at 702 Wulsin Bldg., Indianapolis, Ind. Samuel C. Hadden, Editor and General Manager.



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East 24th Street, near Art Institute, Minneapolis, Minn., paved with TEXACO Asphaltic Concrete in 1915. Photo taken August, 1921.

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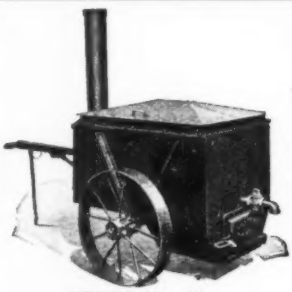

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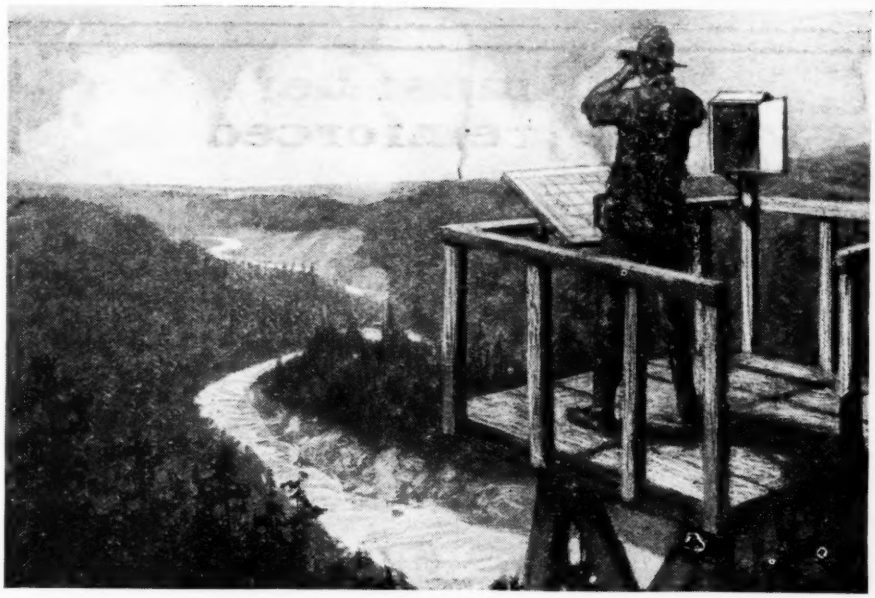

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Built of Selected hardwoods, heavy forgings, castings, and with adjustable wings for clearing six to twenty feet. Operated by horses—truck or tractor. Plows any depth desired.

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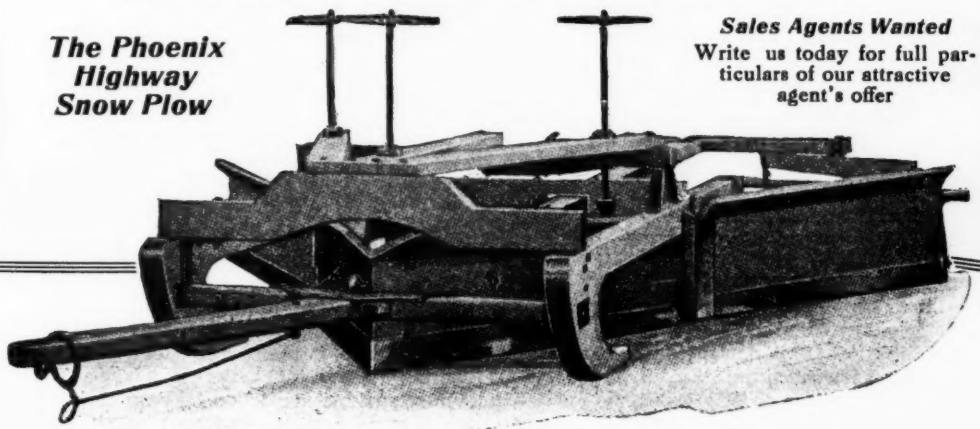

Motor Truck Operation and Accounting—75

HIGHWAY TRAFFIC AND TRANSPORTATION

(Editor's Note: Following is the 1921 report of the Committee on Traffic and Transportation of the American Society for Municipal Improvements. Prof. A. H. Blanchard, Ann Arbor, Mich., is chairman and Messrs. Robert Hoffman, Cleveland, Ohio, and Charles O. Boyd, Beckley, W. Va., are the other members of the committee.

Investigations conducted during 1921 influence the committee strongly to urge the general adoption, by municipal governments, of the recommendations embodied in its 1920 report relative to the following subjects :

Use of "Dummy Cops" at street intersections.

Installation of "Rotary Traffic" at street intersections wherever practicable.

Design and construction of long radius curb corners.

Economic design of street widths on through thoroughfares in small towns and cities.

Utilization of by-pass highways for towns and cities located on important national, state, and county trunk highways.

Consideration of the installation of motor bus routes in municipalities, when an extension of the public passenger transportation system is required, in view of the resulting advantages of such installations from the standpoints of maintaining the maximum practicable traffic capacity of streets and of avoiding the use of car tracks in roadways.

Wild Cat Jitneys Condemned

Based on a careful analysis of public passenger transportation, the committee considers that it is highly desirable, from the standpoints of economic public service transportation and the efficient use of municipal streets by traffic, that the Society should strongly condemn the development of "wild cat," so-called, "jitney" service. Not only is the installation of such service undesirable from the standpoint of the overcrowding of streets with five-passenger public transportation vehicles, but it is obviously unfair to public service corporations, operating under franchises, to be forced to compete with a "jitney" service which almost universally is operating on an uneconomic basis. The present overcrowding of some of the principal thoroughfares of the City of Detroit with hundreds of five-passenger "jitneys" furnishes a striking example of this type of public service transportation development.

Highway Transport Divisions for Large Cities

Your committee recommends that a Highway Transport Division should be installed in engineering or highway departments of municipalities having a population of over 100,000. The duties of this Division would be to deal with all matters pertaining to traffic and transportation which affect the economic design and maintenance of streets and their efficient use by pedestrians and all classes of vehicles.

One of the important functions of such a Division would be to make highway transport surveys as preliminary to the design and redesign of streets, the determination of efficient methods of maintenance and the formulation of recommendations pertaining to efficient traffic regulations.

A highway transport survey embodies all investigations in the field and office which are necessary to determine the probable amount, character and effects of the future traffic which will use a given highway during the lives of its several component parts. Such a survey for a given street may cover a consideration of all of the following factors: First, all highway elements which affect economic highway transport; second, legislation relative to franchises and rates, weights, dimensions and speeds of passenger cars, trucks, tractors and trailers; third, state and urban traffic regulations; fourth, vehicular and population statistics; fifth, traffic censuses of motor and horsedrawn vehicles and cars operating on tracks; sixth, vehicular operation as affecting roadways and other parts of highways; seventh, present and future traffic and commercial transport developments in such fields as agricultural and dairy farming, mines, quarries, gravel and sandpits, oil fields, lumber tracts, fisheries, plants, factories, wholesale and retail stores, parks and parkways, summer and amusement resorts, and real estate im-

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We shall be glad to send a booklet to interested parties which describes the Mack-Cressy Road Sprayer.

INTERNATIONAL MOTOR COMPANY
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PERFORMANCE COUNTS

provements, which affect or will affect the traffic on the street under consideration; eighth, common carriers, such as steam and electric railroads and waterway transportation companies and their relationship to street traffic; and ninth, the characteristics of the methods of highway transport such as street car, rural, interurban and urban motor-bus operation, municipal haulage, long and short general rural haulage, rural motor express, intercity haulage, intercity express, and horse transport.

Men assigned to a Highway Transport Division should be experienced highway engineers who have or are rapidly acquiring a knowledge of the following subjects: City planning, highway transport economics, legislation, surveys and methods; highway transport management, including delivery systems, scheduling and routing; traffic regulations; interrelationship of highway, railway and waterway transport; port, terminal and warehouse facilities; and the fundamentals of the mechanism and operation of automobiles, motor trucks, tractors and trailers.

FIVE-TON TRUCK PAYS FOR ITSELF IN 18 MONTHS ON CONSTRUCTION WORK

By G. A. Van Dusen, 685 Greenwood Ave. Detroit, Mich.

I purchased a 5-ton Acme truck in September, 1919, and since then it has not only paid for itself, but has also made me a good living.

This truck is equipped with a 5yd. dump body and hoist, and was bought especially for road work; but I have been using it on various hauling jobs, such as road building, excavating, hauling building supplies, etc., in Michigan, Indiana and Illinois. During its 18 months of operation the truck has traveled 18,704 miles, and averaged around 35 miles a day.

The mileage per day depends on the job. Some road jobs average around 80 miles a day, while in handling building supplies and ordinary hauling the average is only 20 or 25 miles. The length of time spent on various jobs also varies. Sometimes the job lasts only two or three days, while other jobs may last two or three months.

With my truck I have never hesitated to take on any job which a motor truck had any business to tackle. Excavating work is particularly hard on a truck. It requires going down into an excavation, taking on a load anywhere up to 8 tons, and climbing up a rough, soft incline which would tax any make of truck. And on road building jobs the roads are usually rough, and so hard on a truck.

The truck, I find, will pull through places where other trucks are held up. In fact, some contractors specify their preference for Acme trucks on their jobs, because some other makes are likely to get stuck and hold up the entire job. My truck has pulled many another truck out of a bad place. All the work I go into is hard compared with what a truck on city work runs into.

During the year ending March 1, 1921, the truck traveled 9,456 miles in 270 days. Figured on the National Standard Truck Cost System, it costs $16.05 a day

ACME 5-TON TRUCK AS OPERATED ON CONSTRUCTION WORK BY G. A. VAN DUSEN, DETROIT, MICH.

to operate. This includes $5 a day to me as driver. I am allowing $400 a year for maintenance and repairs. The operating costs, of course, vary according to the work done.

One day I hauled 14 loads of asphalt a distance of 1½ miles, making an average of 7.3 tons per load. The cost of operation was:

Variable expense—42 mi. @ 23.69c.	$ 9.95
Fixed expense—1 day	2.76
Driver's wages—1 day	5.00
Total operating cost per day	$17.71

Hauling 102 tons on this day made the cost of hauling 17.3 cts. per ton, and 11½ cts. per ton-mile. The usual day's work on this job was 11 trips, but on this particular day I got in 14 trips.

On one job I was hauling gravel a distance of 8½ miles, making a round trip of 17 miles. As I hauled 4 loads a day, I covered 68 miles. The roads were paved

Vocational Truck Selection

It is the opinion of many in the truck industry that truck buyers will pay increasing attention to the service rendered by trucks in any specific field in buying trucks to use in that field. Of course this is a natural method of selection but many buyers in the past have not paid particular attention to the performance of truck types in their field before placing their truck orders.

It is held by many that within the next very few years the great majority of all trucks sold will be sold on the **Vocational Plan,** because the public will insist on being shown just what trucks have done and will do in actual operation in the line of business in which the buyer is engaged and not in some outside line.

It is now possible for prospective buyers of trucks to secure detailed and accurate information regarding truck performance in every field.

We can assist you, without charge, in selecting trucks that have made good in the municipal and county construction field if you so request.

Municipal and County Engineering

702 Wulsin Bldg. **Indianapolis, Ind.**

all the way, and part of the haul was over city streets. The cost was:

Variable expense—68 mi. @ 23.69c.	$16.10
Fixed expense—1 day	2.76
Driver's wages—1 day	5.00
Total operating cost per day	$23.86

I averaged 6 cu. yds. to the load, or approximately 8 tons. The cost per cubic yard was 99 cts. or 11 cts. per cu. yd.-mile. The cost per ton was 74½ cts., or 8.7 cts. per ton-mile.

On a certain road building job, I usually hauled 10 loads a day a distance of 3½ miles, making 70 miles a day. The roads were good, though slightly hilly. The costs were:

Variable expense—70 mi. @ 23.69c.	$16.58
Fixed expense—1 day	2.76
Driver's wages—1 day	5.00
Total operating cost per day	$24.34

As the truck hauled 6 cu. yds. per trip, the cost was 48.5 cts. per cu. yd. and 11 cts. per cu. yd. mile.

During its first year of operation the truck was a big source of profit to me. I had plenty of work, and was getting $1 a yd. or $4 an hour, according to the nature of the work. In 18 months it paid for itself and earned me a good living besides. The truck has not been operating so steadily lately, but as business is getting better I expect it will soon be busy again.

AVERAGE COST OF OPERATING 5-TON ACME

Owned and operated by G. A. VanDusen, Detroit, Mich.

Cost per day (including driver)	$ 16.05
Cost per mile	.4585
Total cost for period	4,335.93
—Operation—	
Days operated	270
Miles traveled	9456
Miles per day	35.02
Miles per gallon of gas	4.5
Miles per gallon of oil	150
—Itemized Cost—	
Driver cost per day (incl. above)	$ 5.00
Depreciation per mile	$ .1128
Maint. and repair, actual, total	$.
Maint. and repair, actual, per mile	.
Maint. and repair, esti., per mile	.0423
Tire cost, actual, per mile	$ .0172

MUSHROOM TRAFFIC LIGHT PREVENTS ACCIDENTS

Ten months ago the first Mushroom Traffic Light was placed in Milwaukee and since then this light has been adopted in many other cities, including Indianapolis, Chicago, Minneapolis, Detroit, St. Louis, Kansas City and many smaller cities. This light, here illustrated, is the latest development in a traffic light or signal that is discernible by day or night, and yet proves harmless if struck by an automobile or other moving vehicle. If one of the wheels of an auto strikes the steel shell it either slides off to one side or may pass over the top without injury either to the light or the automobile. By dividing traffic and keeping motorists where they belong collisions are largely prevented.

The device is an 18 in. hemisphere of brilliant light, rising 8 ins. above the level of the pavement, in the center of street

VIEW OF THE MUSHROOM TRAFFIC LIGHT.

intersections. It is for intersections where the traffic is heavy, but where a crossing policeman is not regularly stationed. The very presence of the signal denotes a busy corner even to the tourist.

The National Safety Conference has recommended the Mushroom Light to the Liability Insurance companies as a means of accident prevention, which would lower the cost of insurance and save money to motor vehicle owners.

It is a simple looking thing—a well guarded, brilliantly colored hemisphere—set in the roadway as though one had set a flare in the street, but in reality it is somewhat intricate and is carefully worked out on scientific principles of illumination, and those of psychology, too.

This new light was designed to replace the old iron post or silent policeman that stood majestically in the road, conceived and executed on the lighthouse plan—way up in the air—where a motorist's eye should never be. Let the mariner fix his eyes on the stars, there are no bumps in his road—but the man at the wheel must keep his gaze on the right of way. His line of vision is always down on the

When You Buy a Motor Truck

Select it with care for
It makes a difference (*to you*)

what truck you buy. Your truck should be selected to suit the character of work you expect it to perform.

You would not think of buying a pump in the open market without first satisfying yourself that you are selecting the right type and size to handle your pumping job, and you should not buy a motor truck, at random, without giving careful consideration to the size, type and other features it should have to meet satisfactorily the conditions under which you expect to operate it.

There are over 200 makes of trucks on the market. Any truck manufacturer will take your order, of course, but only a small percentage of all truck manufacturers have made a special study of the trucking requirements of cities, counties, road builders and public works contractors.

These special studies have resulted in up to date, competent motor truck engineering which determines the proper size of truck and the proper truck equipment for solving the various hauling problems of cities, counties, contractors and road builders.

This magazine has published a special Motor Truck Section in every issue for over **six years** and has studied carefully the trucking problems of this fiild and the trucks that best solve those problems.

If in the market for trucks let us know your requirements and we shall be pleased to give you the benefit of expert advice.

Municipal and County Engineering

702 Wulsin Building **Indianapolis, Indiana**

street. There is where the psychology comes in.

The brilliant red, or green, or yellow light, as desired, from this new mushroom light is in line with the eye and is never obstructed by a street car or automobile passing between the driver of the car and the light. It is seen underneath the passing car. It can be put between street car tracks without interfering with the passage of cars or acting as a danger trap for automobiles driving alongside of street cars. Being down in the roadway, the light is always discernible from any angle regardless of approaching or passing cars.

The foundation is set about 4 ins. under the level of the roadway. Above appears the glass hemisphere, made of materials very like that used in kitchen utensils. The design of the grating or covering is where a good part of the science comes in. It is so arranged with reference to lines of illumination and optics that as one approaches the light the angle remains the same; the steel ribs do not appear at all, and the mushroom is always a solid ball of light.

To make the brilliant bit of illumination only two 60 watt lamps are used under the glass. The light of the two bulbs is so multiplied by the refraction of the glass and reflection of the shell that the candle power is seemingly much greater.

Another point to the Mushroom is the way a big truck with an overhang, which was almost bound to hit the silent cop or the iron post, can ride right over the mushroom light and even if it runs over it with a wheel—the heaviest truck made, fully loaded—cannot injure the light.

The first one of these lights to be installed was on an important street corner in the City of Milwaukee, and the city records show that the old iron post (such as is in common use in our cities at the present time) which stood on this corner previous to the time the mushroom was installed, was in an accident on the average of every five days, doing damage to the post to the extent of anything from merely breaking the glass globe on top, which meant an expenditure for the city of ten or twelve dollars, up to the complete demolition of the post, which meant an expenditure of many, many times that amount. This does not take into consideration the damage done to the cars that collided with the post. The amount of that damage is best known to the drivers that hit it. The Mushroom Light that replaced this post has been there nearly a year without one cent of expenditure for upkeep by the city or drivers except painting from time to time.

This traffic light is marketed by the Electrical and Specialty Co., Madison Terminal Bldg., Chicago.

SHORT COURSES IN HIGHWAY ENGINEERING AND HIGHWAY TRANSPORT

The University of Michigan is the only institution which offers courses, of the kind here outlined, for men engaged in the practice of highway engineering and highway transport and which may be taken during leaves of absence of from two weeks to four months. The courses will be offered during the winter period of 1921-1922. These courses will be given in periods of two weeks each. A man may take one course or a group of courses. For further information, write to A. H. Blanchard, University of Michigan, Ann Arbor, Michigan.

December 5 to 16, 1921

C. E. 72. Earth, Sand-Clay, Gravel and Broken Stone Roads. Professor Smith.

C. E. 81. American and English Highway Transport Methods. Professor Blanchard.

December 19 to 31, 1921

C. E. 77. Highway Engineering Financing, Management and Organization. Professor Smith.

C. E. 79. Highway Transport Legislation and Traffic Regulations. Professor Blanchard.

January 2 to 13, 1922

C. E. 78. Grading Machinery and Operations. Professor Bateman.

C. E. 80. Interrelationship of Highway, Railway and Waterway Transport. Professor Riggs.

January 16 to 27, 1922

C. E. 68. Bituminous Surfaces and Bituminous Pavements. Professor Blanchard.

C. E. 82. Highway Transport Costs and Record Systems. Professor Smith.

January 30 to February 10, 1922

M. E. 40. Mechanism, Operation and Maintenance of Motor Trucks, Tractors and Trailers. Professor Lay.

C. E. 69. Highway Laboratory Research. Professor Bateman.

C. E. 70. Highway Structures. Professor Gram.

C. E. 84. Highway Transport Management. Professor Smith.

February 20 to March 3, 1922

C. E. 67. Highway Transport Economics and Surveys. Professor Blanchard.

C. E. 73. Brick, Cement-Concrete, Stone Block and Wood Block Pavements. Professor Bateman.

March 6 to 17, 1922

C. E. 71. Highway Specifications, Contracts and Jurisprudence. Professor Riggs.

C. E. 75. Highway Engineering Seminar. Professor Blanchard.

C. E. 76. Highway Engineering Theory and Design. Professor Smith.

C. E. 83. Highway Transport Seminar. Professor Blanchard.

CONCLUSIONS ON HIGHWAY ENGINEERING COURSE

(Editor's Note: Following are the conclusions relative to highway engineering courses embodied in the 1920 Report of the Committee on "Civil Engineering" of the Society for the Promotion of Engineering Education, as presented at the recent annual meeting of the society by the chairman, Arthur H. Blanchard, Professor of Highway Engineering and Highway Transport, University of Michigan.)

1. In four-year civil engineering curricula without technical electives there should be included a course in the fundamentals of highway engineering aggregating three hours per week throughout one collegiate year.

2. In four-year civil engineering courses with options there should be included a required 2 or 3 hour semester course or a course aggregating 30 to 50 hours in the fundamentals of highway engineering, and optional courses aggregating 6 to 9 hours a week for one semester which would include courses in the theory and economics of highway improvements, highway design and highway laboratory.

3. In not less than ten universities, located in different geographical sections of the United States, there should be offered short period advanced courses covering all phases of highway engineering. These advanced specialized courses should be designed primarily for men who have taken a first degree, who have acquired a knowledge of the fundamental principles upon which such advanced courses are based, and who have had a certain amount of experience in highway engineering. It is evident that such courses should be given under such conditions that it will be practicable for engineers and others engaged in highway engineering to take advantage of the opportunities offered. Such courses, given in a concentrated form in short periods of from two to three weeks during the winter months, constitute the most efficient method of meeting the demand of practicing engineers for advanced technical education in highway engineering. Graduate courses of this type were fully explained in a paper entitled "Graduate Courses for Practicing Engineers," presented before the society in 1916.

4. One engineering institution in each state should conduct, sometime during the winter months, a highway engineering conference, of about one week in length, for the discussion of the highway engineering problems of the state by the engineers and officials of the state, county and municipal highway departments.

VALUABLE TRADE LITERATURE

Skimmer Boom Attachment for Excavator Crane.—The Pawling & Harnischfeger Co., of Milwaukee, Wis., has issued Pamphlet TX, which describes and illustrates the new Skimmer Boom designed for attachment to the standard P. & H. 205 or 206 Excavator-Crane. The point is made that by replacing the standard boom of either of these cranes an efficient road grading machine is provided. In fact, this is similar to the shovel attachment brought out earlier this year and which is designed for use with either of the two types of P. & H. cranes mentioned. Data and operating cost figures on a road grading job done by William Datka, contractor, are included, together with a profile for the road prepared by the county highway department.

How to Build Asphaltic Concrete Pavements.—"Tell me how to do it and make it short." That is the first sentence in the text of the new booklet entitled "Texaco Asphaltic Concrete," recently issued by the Asphalt Sales Department of The Texas Company.

The entire booklet carries out the thought of the first sentence, because it tells in a thorough but brief and interesting manner just how to build an asphaltic concrete pavement. In addition to the literature giving each step in construction, there are excellent illustrations which show how a Texaco Asphaltic Concrete pavement is constructed. Engineers, contractors, or public officials who want a copy of this booklet may get one by

addressing the office of this paper or by writing direct to The Texas Company, Asphalt Sales Department, 17 Battery Place, New York City.

Road Maintenance with Tarvia.—The purpose of this new Tarvia booklet is to show the various methods of maintaining pavements of every description. The booklet also describes and illustrates the steps to be taken in patching every type of roadway. These methods are so clearly described and accurately illustrated that by simply following the instructions given any variety of pavement can be easily maintained.

Austin Rollers, Motor and Steam.—This is the title of an exceptionally useful 9x12 in. 64 page catalog recently issued by the Austin Manufacturing Co., Wrigley Bldg., Chicago. Every road roller need is catered to in the Austin line; steam rollers, both coal and liquid fuel burning types; motor driven rollers using gasoline or kerosene are built in three types and a large range of sizes from 5 to 15 tons in weight; Austin tandem rollers are favorites with the paving contractors and city street departments. Country road builders, township, county, state and federal governments have endorsed Austin Steam and Motor Macadam Rollers. The entire line of rollers is fully illustrated and described in this catalog.

Snow Plows.—The Champion and Climax Snow Plows, of the Good Roads Machinery Co., Inc., Kennett Square, Pa., are illustrated and described in this 7x10 in., 32 page catalog, which also contains much valuable information on removing snow from roads and streets.

Steel Pipe.—The manufacture and use of Hammer-weld steel pipe in sizes of 24 to 96 ins. in diameter is described in Bulletin No. 13, issued by the National Tube Co., Frick Bldg., Pittsburgh, Pa.

Asphalt-Block Press.—A bulletin descriptive of their new asphalt block and tile press has been issued by the National Moulding Press Corp. of 262 Fulton St., Brooklyn, N. Y. It is claimed this is the first press of this sort to be placed on the market at a price within the reach of every contractor and plant owner.

Austin Motor Sweepers—This circular illustrates and describes the Austin Motor Sweeper made by the Austin-Western Road Machinery Co., Wrigley Building, Chicago, Illinois. It would be of direct interest to many municipal and county officials. The design of the sweeper is illustrated and described and several views showing it in operation are presented.

BRITON CALLS OUR ROADS NARROW AND DANGEROUS

Alfred Dryland, Chief Engineer for Middlesex County, England, recently came to this country for a six weeks' inspection of highways. His comments are of interest, as for example: "Road-building is making great progress in America, but the great weakness in your system is your partial development of width. Little attention, also, seems to be paid to the edge of the road. There is a large mileage of roads that are not up to date. You have an enormous area to develop. I have traveled more dangerous roads in the vicinity of New York than in my entire 40 years of experience in England. Your roads are dangerous, because the paved widths are too narrow for the amount of traffic they bear. There should be a minimum width of 30 ft. of pavement, affording room for at least three vehicles to pass. The United States, however, is developing excellent pavements. It is only a question of time and money until you will lead the world, both in the quantity and quality of your roads."

THE RESPONSE OF SCRANTON, PA.

To the Editor:

I have read your editorial: "Building or Breadlines," in your September issue, and I take great pleasure in saying that your article hits the nail on the head. Although we are fairly prosperous in the anthracite coal fields, I have called a meeting for the purpose of discussing the question of unemployment and have sent invitations to the following officials and business men to be present: All city officials, county officials and school board officials who have charge of appropriating money for public uses; the president of our Board of Trade, the presidents of the Rotary Club and Kiwanis Club, the presidents of our largest banks, the publishers of our daily papers and other business men whom I know will give their best advice on the question of unemployment.

Very truly yours,

ALEXANDER T. CONNELL, Mayor,
Oct. 10, 1921. Scranton, Pa.

EDITORIAL

ARE WATER DEPARTMENTS AND COMPANIES LIABLE FOR FIRE LOSSES WHEN WORKS DO NOT FUNCTION PROPERLY

Of vital interest to every water utility in Indiana, whether privately or publicly owned, and of great interest and concern to every water works and other public utility man in the entire country is the New Albany (Ind.) water works case which has passed through the Appellate Court with a decision against the utility, and in which the Supreme Court of Indiana has been asked to take jurisdiction.

Very briefly, the New Albany Water Works was sued for $25,000 damages on account of a fire loss which, it is contended, could not have occurred but for the fact that a fire hydrant, immediately across the street from the damaged property was out of order. The lower court was not in sympathy with the claim against the utility and the case was carried to the Appellate Court which held in favor of those who suffered the fire loss. The utility then filed a petition asking the Supreme Court to take jurisdiction and several briefs in support of the petition for transfer to the Supreme Court have been filed, by permission of the Court, of course, by attorneys for both publicly and privately owned water utilities in Indiana.

It seems, therefore, that if the views of the Appellate Court are sustained by the Supreme Court, not only private water companies but municipal water departments as well will be subject to damage suits whenever there is a fire loss and a suggestion is made that some part of the water works system was not functioning properly, thus contributing to the extent of the fire loss. In other words, if this view prevails, all Indiana water utilities will find themselves in the fire insurance business, so far as liabilities are concerned, but without collecting any premiums or fees for assuming such risks. Is it any wonder Indiana water works men are disturbed at the possibilities inherent in such a state of legal opinion?

The utility under discussion formerly operated under a franchise granted by the city, but sometime before the fire in question occurred, surrendered its franchise to the city and received an indeterminate permit to operate under the Indiana State Public Utilities Act and to render the same service as provided for in the original franchise, including fire hydrant service. Now it is conceded by all parties that under the common law as interpreted by the Indiana Supreme Court, as well as by the courts of other jurisdictions, there was no liability to the individual citizen of the municipality for the reason that there was no privity of relation between the citizen and the utility. The question of the common law liability has not, therefore, been involved in this case and the utility's liability, if any, comes under the provisions of the State Public Service Act.

The State Public Service Act provides, among other things, that when a utility surrenders its franchise and receives by operation of law in lieu thereof an indeterminate permit to operate, the permit is held under all the terms, conditions and limitations of the Act. The Act also provides (Sec. 7) that every public utility is required to furnish reasonably adequate service and facilities. Section 116 of the Act provides: "If any public utility shall do or cause to be done, or permit to be done any matter, act or thing in this Act prohibited or declared to be unlawful, or shall omit to do any act, matter or thing to be done by this Act, such public utility shall be liable to the person, firm or corporation injured thereby in the amount of the damage sustained in consequence of such violation."

The utility claims that the Public Service Law does not provide for any liability of a public utility that did not exist prior to its enactment, while it is contended by the other party to the suit that by passage of the Act Indiana has fundamentally changed the law governing Public Service Corporations, and that under the Act the management and control of such corporations has been taken over by the State and by statutory enactment the State has determined the obligations, duties, rights and liabilities of such corporations, not only to the State and the municipality in which they operate, but to the general public and the individual intended to be served by such Public Service Corporation, and that by such enactment a liability has been created where none theretofore existed.

The judge of the Appellate Court who

pronounced the decision against the utility, in the course of his decision, said: "Recognizing as we must, that before the passage of such Public Service Act there was no liability on the part of the public service utility to an inhabitant of a city within which such corporation was operating under a franchise for injuries suffered by such inhabitant because of the negligent acts of such public service utility, we are wholly unable to interpret the sections aforesaid, Nos. 7 and 116, of the Public Service Act, so as to make them simply an enactment of the common law principle theretofore established and by such interpretation thereby make the provisions aforesaid an absolute nullity. By the use of language so plain of understanding and so easy of interpretation, we must hold that the legislature intended thereby to change the law so as to create a liability that did not theretofore exist, and it has created a liability in favor of the individual injured because of the negligence of such public service utility in failing to furnish reasonably adequate service of water for fire protection."

Sections 7 and 116 of the Indiana Act are substantially copied from corresponding sections of the Wisconsin Act except that the Wisconsin Act provides for treble damages and was interpreted by the Wisconsin Supreme Court to be penal and hence covering only wilful breaches of duty, or breaches in which there is some element of wilfulness, wantonness or evil design. The Indiana Appellate Court calls attention to the omission of the word "treble" in the Indiana Act "thereby making the trespassing corporation liable to the person, firm or corporation injured only in the amount of damages sustained in consequence of its violation of the law."

This significant statement is embodied in the decision of the Appellate Court: "The question involved was the interpretation of the statute, and we must confine ourselves to its interpretation as it is written, and if when so interpreted it seems to inflict undue hardship upon the parties affected thereby, that is a matter for the future consideration of the legislative department of the State."

The utility has asked the Indiana Supreme Court to take jurisdiction in the case and render a decision in the premises on the grounds that the Appellate Court in its decision overrules ruling precedents of the Supreme Court and erroneously decides a new question of law. As stated, several briefs have been filed by "friends of the court" and others may be filed if it is felt all points have not already been covered.

Of course this magazine has no way of knowing whether the Supreme Court will take jurisdiction in the case or not and if it does what its decision will be. But this much is evident to all: The opinion of the Appellate Court, if upheld, will create an intolerable and hazardous situation for every water, or similar public utility, in the State of Indiana. Moreover, as all the State public service laws are fundamentally much alike, a final adverse decision in Indiana is bound to make expensive trouble, when cited as a precedent, for public utilities in other states. The case, therefore, is of national importance.

This case, based on the condition of a fire hydrant, ideally illustrates the impracticability of assuming such liabilities as the Appellate Court reads into the Indiana Act. Every water works man knows that the use of fire hydrants for unauthorized purposes is a very difficult thing to control. A water department or company may leave a hydrant in perfect condition when along comes an employee of the Street Department, or a contractor's foreman, and opens the hydrant. He may injure the mechanism of the hydrant in closing it, or may not completely close it and it fills with water and freezes. Revolving nuts are sometimes turned the wrong way and broken, or so battered by pipe wrenches that standard wrenches, when later applied, will not open the hydrant. Practically speaking, it is an absurdity to hold utilities legally responsible for such common occurrences as these which cannot be entirely eliminated by painstaking routine inspection.

No time should be lost in planning amendments to State public service acts, where they are needed to restore and safeguard the original, common law rights of public utilities, and these amendments should be enacted into law at the earliest possible moment; for so long as there are courts who are at all likely to view this matter as the Indiana Appellate Court has done, such provisions as are contained in Section 116 of the Indiana Act are a menace to the existence of public utilities. Such legal decisions will make the ownership of public utilities so hazardous that communities as well as private business corporations may well decline to engage in such enterprises. The menace of such decisions must therefore be removed by amending the basic laws.

BITUMINOUS CONCRETE PAVEMENT BETWEEN INDIANAPOLIS AND GREENWOOD, IND.

By G. R. Harr, Office Engineer, and R. E. Simpson, Project Engineer, in charge of construction of this Project, Indiana State Highway Commission, State House, Indianapolis, Ind.

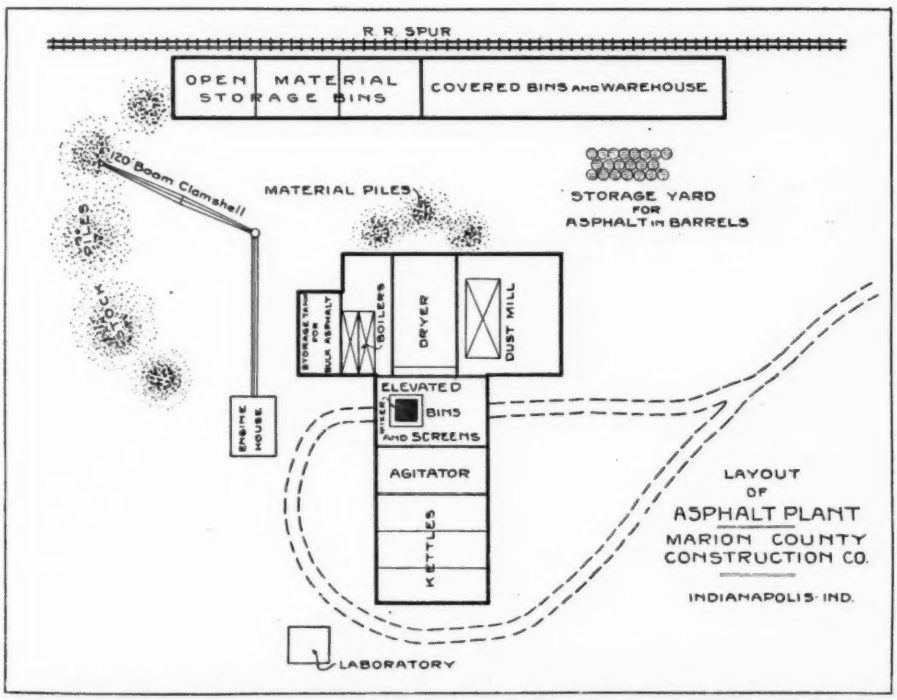
Although estimates are made and bids are received by the Indiana State Highway Commission for three types of hard surfaced pavements on every road improved by it, in but two instances have roads been constructed with Bituminous Concrete. One of these is that part of the Michigan Road between South Bend and the Michigan State Line and the other is the Madison Road between Indianapolis and Greenwood, a part of the Jackson Highway, known as State Road No. 1, Sections A and B.

Surveys were made and plans partially prepared by the first commission which was organized under the 1917 law. When the commission was reorganized, in May, 1919, the plans for the Madison road were revised and rushed to completion. In the preparation of these plans it was intended that the old macadam roadbed should be used as a foundation for the new pavement wherever possible. Consequently the excavation was rather light, averaging 3,150 cu. yds. per mile.

At the first letting held by the commission the contract for the improvement of this road was awarded to the Marion County Construction Company, Indianapolis, Ind., the only bidders, for a Bituminous Concrete Pavement. This pavement consisted of a 6 in. concrete base course, 1 in. binder course, and a 1½ in. wearing course. The contract was awarded on July 19, 1919, and construction was started a few days later.

Central Mixing Plant Used at Outset

The contractor's scheme of construction was to begin at the north end of the project, the south corporate limits of Indianapolis, and work south. A central mixing plant, for the construction of the concrete base, was erected about two miles south of the city, to which materials were to be brought by truck and the concrete was to be transported to the grade in other trucks. For this purpose five 2½ton Nash Quad trucks were rented from the commission. As soon as sufficient base was laid to permit the asphalt plant, which was located in Indianapolis, to operate continuously for a few weeks it was intended to lay the surface, starting at the southern extrem-



LAYOUT OF ASPHALT PLANT OF THE MARION COUNTY CONSTRUCTION CO. ON THE INDIANAPOLIS-GREENWOOD, IND., BITUMINOUS CONCRETE ROAD.

ity of the base and work north. The bituminous concrete was to be hauled from the plant in 5 ton trucks owned by the contractor, the average haul being about seven miles.

Bonding Binder and Base

Considerable trouble was had in finding a local gravel plant that could furnish material which would meet the specifications for mechanical analysis and work on the base course was not started until Oct. 13, 1919. Meanwhile the contractor had completed the cross drain culverts and grading for a distance of about two miles south of the north end as well as considerable grading further south. About 2,500 lin. ft. of base was built. It was found that tamping the concrete with a tamp having a smooth face left the base too smooth, for a good bond between it and the binder course, so several reinforcing bars were fastened across the face and the desired roughness given the base with it. Construction was continued until Nov. 22nd, when work was closed down for the winter.

Central Mixing Plant Discarded

During the winter the contractor made arrangements to use crushed stone for coarse aggregate and as the progress with the central mixing plant, on the construction of the base course, had not been what was desired, they decided to abandon it and use another construction scheme. Stock piles of stone and sand were distributed at intervals of 500 ft. along the finished grade. An 18E Koehring Paver was obtained and when the construction season of 1920 was opened the aggregates were loaded into two-wheeled one-horse dump carts in the proper proportions, hauled and dumped into the skip of the mixer. Cement was brought in sacks from storehouses on a light truck and was dumped directly into the skip. As the crushed stone was difficult to handle with shovels, a Keystone Skimmer which had been used in making the grade was tried out at the stone stock piles and very satisfactory results were obtained using it to load the stone.

The concrete base is 6 ins. in thickness at all points, the sub-grade being given the same crown as the pavement. A curb 6 ins. wide and 2½ ins. in depth is built on each side of the base. This curb was built monolithic with the base, although the mix for the base is 1:3:6 while that for the curb is 1:2:3. The total width of the pavement is 18 ft. and the pavement is given a crown of 2 ins.

The Bituminous Surface

On May 3, 1920, the laying of the bituminous surface was begun. This consisted of 1 in. of closed binder and 1½ in. of surface, a Topeka type of asphalt concrete. This first run was made with Trinidad asphalt, although Aztec Mexican oil asphalt was used on some other runs. No more binder was laid in one day than could be covered by the following day's run of surface course. A sketch of the layout of Bituminous plant used for this work, shown herewith, was a very well arranged and efficient plant.

Transportation difficulties and inefficient labor common to all construction work during the 1920 season retarded the progress of the work so that the end of the season found the contract only 74 per cent complete. A feature of last year's construction was the last run of surface laid in the first week in December with a haul of 7½ miles. In spite of the low temperature and long haul, this run was closed even better than some of the surface laid earlier in the season. This was due to the efficient work of the men both at the plant and on the road.

All grading was completed before the construction season opened up in 1921 and rapid progress was made with the base course when the work was started. This year, with more efficient labor and better transportation, the true efficiency of the scheme of construction was demonstrated. An Indianapolis plant was able to furnish satisfactory gravel and the last part was constructed with it as the coarse aggregate. The last surface was laid on June 30th and the road was immediately opened to traffic.

Cost

This project is 7.307 miles in length, constructed at a cost, exclusive of bridges over 20 ft. clear span, of $284,065.48. Two bridges of over 20 ft. clear span were constructed under separate contracts at a cost of $14,768.12. This added to the cost of the road makes a grand total of $298,833.60. Average cost per mile, including bridges, $40,896.89; exclusive of bridges, $38,721.30.

USING SEWAGE SLUDGE GAS FOR POWER PURPOSES

The possibilities of sewage sludge gas as a driving power were discussed before the Engineering Section of the British Association meeting at Edinburgh recently by Mr. John D. Watson, engineer to the Birmingham, Tame and Rea Dis-

trict Drainage Board, and reported in The Surveyor of London, as follows:

At Birmingham, said Mr. Watson, recent experiments had shown that it was practicable and economical to drive a suction gas engine with gas derived from sewage sludge. That organisms acting on decaying vegetable had contributed to the formation of gas capable of being put to use was not unknown to the scientific world, but, suggested the speaker, to employ gas emanating from sewage sludge to drive plant which formed an essential part in an installation for the purification of sewage was an achievement calculated to interest the economist.

Mr. Watson pointed out that the volume of wet sludge dealt with at Birmingham was not less than 400,000 tons per annum. Similar volumes were sent out to sea from Glasgow and Manchester, and correspondingly less from Dublin and Southampton, but from London not less than 2,000,000 tons were shipped every year. He estimated that from Birmingham alone 9,000 tons of dry solid matter were available to produce 320,000,000 cu. ft. of gas, which was equal to 16,000,000 horse-power hours, taking 20 cu. ft. per brake horse-power, which was equivalent to 4,400 horse-power per day of 10 hours. If one were to be guided by the yield of gas from sewage at Parramatta, New South Wales, these power estimates would be considerably higher, but even after allowing for errors in calculations the volumes of sludge capable of being gassified in our great cities were startling. What was possible in a climate like Australia's, however, was not necessarily obtainable in the British Isles, and he therefore confined himself to facts and experience obtained from Birmingham sewage and the experimental station which formed part of an auxiliary work in course of construction at Cole Hill, where neither electric nor coal-gas mains were available for power.

The plant was designed to give 25 brake horse-power for a working period of six hours per day. It was working under many disadvantages at present, which would not have been the case had there been more knowledge of the subject available when the plant was designed and more confidence in the ultimate success of the experiment. For instance, the gas holder, which was an essential feature of a smooth working plant where gases of varying quantity had to be evenly diffused, was not yet erected, its erection having been delayed until the result of the experiment justified the expense.

Notwithstanding drawbacks, the material fact arising out of the experiment was the successful trial run of the engine and pump and the low cost of gas production. The engine was a standard town gas engine, capable of giving 34 brake horse-power maximum with town gas having a calorific of 500 to 550 B. T. units, and judging from the experience already obtained there was every reason to expect gas of a higher calorific value, probably 650 to 700 B. T. U. Given a regular supply of gas perfectly satisfactory results were assured, and it might be assumed that the engine would require no more attention than the standard gas engine working on town gas.

It was, remarked Mr. Watson, in conclusion, too early to dogmatize upon what were the most favorable conditions, but it was the duty of every local authority in these days of enforced economy to see that the gas that had hitherto been disposed of as something which was of less than no value was utilized when possible and practicable.

USE OF DRAINAGE WELLS ON HIGHWAY CONSTRUCTION IN NEW MADRID COUNTY, MO.

By Edwin S. Austin, Secretary, State Highway Department, State House, Jefferson City, Mo.

Building roads in Missouri requires the solution of more types of engineering problems, perhaps, then in any other state. Because of its peculiar topography, highway building necessarily takes on difficulties of mountain construction, and on the prairie land a different construction is required. The flat country in Southeast Missouri requires the solution of even more difficult problems in road building. Particularly is this true on a new road now under construction in New Madrid County.

New Madrid is the oldest settled county in the state, and was the center of what was known as the "New Madrid Earthquake," which destroyed many lives, 150 years ago. This land is of peculiar formation, and until drainage ditches were constructed the land itself, in many parts of these counties, was covered mostly with swamps. The construction of the drainage ditches eliminated the swamps, and resulted in the formation of large tracts of almost level land for miles and miles, as rich as any land in the valley of the Nile. The soil is composed of rich loam, in which at intervals are what is known as "Sand Blows."

South of Sikeston, in Scott County, and through New Madrid County, is a ridge of land that is hardly discernable without the use of instruments. The surface of this ridge is perhaps 10 ft. higher than the surrounding country. It extends for many miles, and takes the name of "Sikeston Ridge." It has an average width of two miles, and it is right down the center of the ridge, south of Sikeston, to New Madrid, a distance of some 20 miles, that a road is now being constructed.

The road itself is part of the "King's Highway," and will be one of the most important thoroughfares of the state after it is hard surfaced. At present it is a gravel project 16 ft. wide. The contract price was at the rate of $9,735 per mile, and the total cost will be $189,839.76 when completed.

Drainage Presents Greatest Difficulty

The particular feature of this road, and the greatest problem which had to be solved in its construction, was the matter of drainage. Owing to the level surface of the ridge it was impossible to carry off the water in any other way than to construct what is known as "wells" at intervals on both sides of the road. These wells are built of 36 in. vitrified pipe, placed in the ground to a depth varying from 17 to 20 ft. At that distance a coarser sand is found, and the water, when it reaches there, is dissipated, and taken up in quantities. There are some 20 or 30 of these wells in the 20 miles of construction, and the water flows to the points where the wells are located and disappears. This method of disposing of surface water had been in vogue in Southeast Missouri at a number of points for a great many years. It had been found that it was the most satisfactory method of securing proper drainage and the disposal of surface water. So far as completed, these highway wells keep the surface of the ground practically clear of water, even when the rains are severe.

Outside of this Southeast Missouri district such methods of drainage have not been undertaken at any other point in the state. But here, in the flat country, it is absolutely necessary to make some provision for drainage, and these wells have been entirely satisfactory, and, it is believed, will prove so in the future.

For that reason this 20-mile project in New Madrid County is something unusual in the way of surface drainage and an interesting problem in highway construction.

REVOLVING SPRINKLERS FEATURE NEW SEWAGE DISPOSAL PLANT AT LEBANON, IND.

By L. A. Geupel, Director of Water and Sewage Department, Indiana State Board of Health, State House, Indianapolis, Ind.

The sewage of Lebanon, Ind., flows into a 24-in. tile interceptor and empties into Prairie Creek. Prairie Creek is a very small stream which can be crossed by a single step in dry seasons. The sewage, about 500,000 gal. per day, flowing into the small stream putrified and an offensive odor came from the stream for many miles below Lebanon.

Local Conditions

The nuisance created became so bad that in February, 1914, a petition was sent the State Board of Health stating that "the city of Lebanon, in Boone County, is discharging and is permitting to be discharged into said Prairie Creek the sewage from the city and is thereby materially injuring, for domestic use, the character of the water in said Prairie Creek to the injury of the public health and comfort."

On receipt of the petition an investigation was made by the Water Works and Sewage Department of the State Board and a recommendation made that "the city of Lebanon be ordered to abate this nuisance by elsewhere disposing of its sewage or by the construction of a purification plant." An order was issued by the State Board of Health on October 9th, 1914, to the city of Lebanon to cease the pollution of the water in Prairie Creek by the discharge of its raw and unpurified sewage and to make an order waiving a trial and hearing before the State Board of Health. The records show that on Nov. 9, 1914, the Common Council acknowledged service of notice and made an order waiving its right to trial and hearing before the State Board of Health.

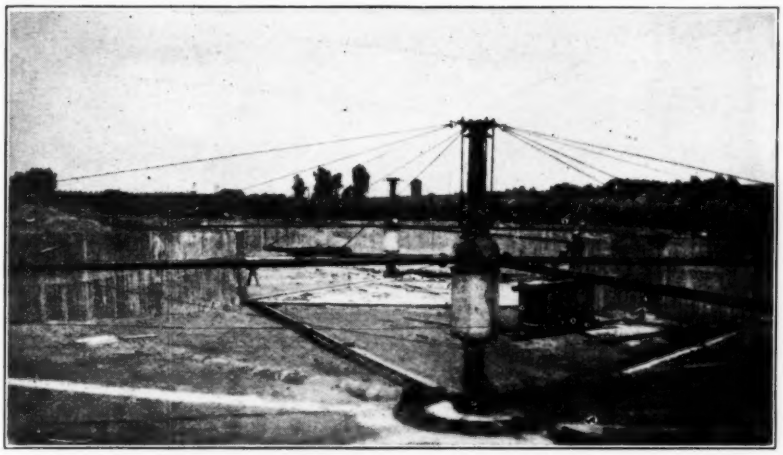
On June 29, 1915, the Secretary of the State Board of Health finding that the order of the Board had not been carried out, addressed the Attorney General of Indiana advising him of steps taken and requesting his legal advice. On June 30, 1915, the Attorney General replied that since the order had not been complied with by the city of Lebanon he would take legal action at once. Records, however, show no such legal action to have been taken. On Nov. 13, 1919, a conference was held at Lebanon with the City Attorney, City Clerk, City Engineer, and one

of the petitioners and the information gained was that at this time the city was trying to buy the land around the outfall of the sewer. The City Council passed a resolution directing the City Engineer to make investigations relative to the construction of a sewage plant for the city. After delay caused by the high prices of materials and labor, Mr. Charles Brossman, Consulting Engineer, Indianapolis, Ind., was retained, made investigations and drew up the plans and specifications for a sewage disposal plant, the construction of which started early in the year 1921.

Essential Features of the Plant

The sewage from the city of Lebanon flows through a 24-in. tile under the Pennsylvania Railroad fill and into an intercepting concrete manhole, where it can either be led by shear valve control into the sewage disposal plant or by-passed to the creek through the old line. As the sewage enters the disposal plant it flows into the concrete screen chamber where again by sluice gate control it may be by-passed to creek if necessary. The sewage passing through an inclined bar screen with openings about 1 in. wide is pumped by either of two Midwest motor driven centrifugal low head pumps into distributor canal. One of the centrifugal pumps is piped up and controlled by valves which makes it possible to pump from and to any one of the three compartment settling tanks or from and to the sludge chamber. A third suction line is placed through the screen chamber concrete walls for use with a future pump and is blanked in the pump room.

The sewage flows from the pumps into a reinforced concrete distributor trough through three tee openings in the pipe line so as to give an even distribution in the trough. From the trough the sewage flows through six 12-in. openings striking on an inclined baffle built across No. 1 concrete sedimentation basin making an even flow and distribution into the first basin. The sewage in No. 1 basin rises to a certain height and is allowed to flow evenly over the side opposite to distributor trough into No. 2 basin and from No. 2 basin flows into No. 3 basin. Between No. 1 and No. 2 basins and No. 2 and No. 3 basins there are baffles (wood construction) so as to retain the scum. There are also gates constructed in the baffles through which the scum can be conducted from one basin to another.



VIEW OF SPRINKLERS ON SEWAGE FILTERS AT LEBANON, IND., BEFORE BUILDING WELLS AROUND THEM.

The bottom construction of the concrete sedimentation basins is an inverted pyramid, with the apex down which is the low point and forms the sump for the sludge line suction. Each basin also is connected so the sewage can be pumped out of the basin without breaking the scum or pumping sludge. From the third basin the sewage rises through adhesion racks to a reinforced concrete canal leading to the dosing chamber.

Adhesion Racks

The adhesion racks are made up of wooden grids with openings about ½ in. wide. The racks can be raised so that they may be cleaned. The function of the racks is to retain any floating moss or matter carried along with the sewage.

The dosing chamber is built to the left of No. 3 sedimentation basin and has a

flat bottom and one corner of it forms the inlets to two syphons with a connection for the third. The sludge chamber is built to the left of No. 2 and No. 3 sedimentation basin and has the same bottom construction as sedimentation basins so that the sludge may be pumped in or out.

Over the screen chamber, pump room, three sedimentation basins, sludge chamber and dosing chamber there is constructed a common roof frame construction covered with prepared roofing.

As the sewage flows from the syphons it leaves the pumping and sedimentation building thereby having completed its first treatment, which is the treatment and action performed by the anaerobic bacteria.

The Filters

The sprinkler filters (two in number) are constructed of reinforced concrete, circular in form, about 80 ft. in diameter intersecting each other. The under-drain system consists of eight main laterals radiating from a brick receiving manhole constructed around the sprinkler machine. The main lateral channels are constructed in the concrete floor draining to the center manhole and are covered with split tile which covers also the mouth of each lateral. The laterals are placed 18 ins. apart and are made of 8-in. spilt tile imbedded ½ in. in the concrete floor. The sprinkler beds are built up of 14 ins. of 2-in. sharp rock and covered

VIEW OF TWO SPRINKLING FILTERS AT LEBANON, IND., SHOWING UNDER-DRAINS AND WELLS IN PLACE.

Revolving Sprinklers

From the syphons the sewage is forced through tile lines into the sprinklers. These sprinklers are unique as they operate revolving and spraying the filter beds under a very low head (2 ft.). The sprinklers are of galvanized metal construction and are manufactured by the Adams Hydraulic Limited, London. The sewage flows into the center of the sprinkler which operates in a water seal and flows out through four openings from which spray pipes lead on horizontal right angular axes out over the bed. The spray pipes are held in place by wire rope guys and braces. Three-sixteenth holes on one side equally spaced to give good distribution over the width of the bed, produce the centrifugal force which causes the sprinkler to revolve.

with 4 ft. 4 ins. of 1-in. sharp rock. After the sewage is sprayed on the beds it passes through 5 ft. 6 ins. of gravel, through the tile underdrains back to the manhole in the center from hence by an 18-in. tile line to the creek.

The inspection showed the concrete work smooth and hard. Every precaution was taken to make the plant watertight and difficulties were encountered due to part of the plant being built under the ground water level.

The writer is indebted to Mr. Charles Brossman, Consulting Engineer on the plant, for courtesies received while on his visit to this plant and also for the pictures shown herewith.

LANCASTER, OHIO, PAVES ALLEYS WITH BRICK FROM PAVEMENT BUILT 33 YEARS AGO.

By Walter W. Graf, City Civil Engineer, Lancaster, Ohio.

The city of Lancaster, Ohio, had an experience with vitrified paving brick this summer that thoroughly demonstrates the durability of this wearing surface for heavy traffic city streets and country highways. The question, "What is a worn-out brick?" remains unanswered so far as our experiences are concerned.

Brick Laid in 1888

In the spring of 1888 the city paved South Broad street, its first hard surfaced thoroughfare, with 2½x4x8 in. vitrified brick on an 8 in. local gravel foundation and a 1½ in. sand cushion with bituminous filler.

It is said by old residents that neither the gravel base nor the sand cushion was rolled, but that the brick were placed on a loose foundation and rolled with a wooden roller weighted down with pig iron.

This street has had probably the heaviest traffic in the city. All of the freight for several large manufacturing plants, one a heavy castings foundry, has been hauled over Broad street for the last 33 years. Traffic was particularly heavy during the world war.

All traffic seemed to travel in one path as on a country dirt road from the day the pavement was laid. A street car track divides the 52 ft. roadway down the center. As was the practice in that early day, the street was built with an unnecessarily high crown and this also tended to keep traffic in the beaten path. The result of this was that all weight, impact and wear and tear was centralized instead of being distributed over the entire pavement.

Repaving Ordered

With the unexpected increase in heavy motor traffic in recent years the gravel base as constructed proved unequal to the task, and the pavement became rough in the tracks made by the traffic. Repaving was ordered.

VIEWS OF ALLEYS IN LANCASTER, OHIO, PAVED WITH BRICK TAKEN FROM A STREET PAVEMENT 33 YEARS OLD.

When the work was begun the engineering department had no idea that the old brick would be of any value and a steam shovel was started through them. Upon cutting into them it was discovered that those brick in the traffic tracks, although worn down in some instances to not more than 1 in. in thickness, remained unbroken, which speaks very well for brick as a type of pavement for heavy traffic.

Property Owners Want Old Brick for Use in Alleys

It was also discovered that by far the

larger number of brick still were in excellent condition. These were ordered piled up along the street by Service Director Ernest Rowles. Very soon there came a demand from property owners who wanted the used brick for the purpose of paving alleys.

The city offered to furnish the brick to property owners who would agree to pave an alley of at least one block in length. Very soon the demand far exceeded the supply and the brick were all hauled away before the contractor had an opportunity to pile them alongside the street. The property owners sent their own teams and trucks, assorted the brick as they were torn up, and hauled them away.

Mr. Carl Garling, a local contractor, was hired by the property owners to do the construction work and the city engineering department furnished the necessary engineering without cost. The contractor did the work on a cost-plus basis which was pro-rated on the abutting property according to the frontage on the alley.

The Alley Pavements

The type of construction was as follows: 5 in. rolled gravel foundation, 2 in. sand cushion and sand filler. The worn side of the brick was turned down, leaving the smooth side for the wearing surface. With an average of about 1 ft. of grading to do, the cost per abutting foot was about 60 cts. for a 9-ft. alley. Five squares of city alleys were paved.

It is the opinion of this department that the improvement is good for 50 years under alley traffic conditions. This would mean a service life for the brick of 83 years. We were informed the other day that all of the old brick have been spoken for in case we repave any more brick streets.

HIGHWAY ILLUMINATION ON ALBANY-SCHENECTADY ROAD

By C. H. Huntley, General Office, General Electric Co., Schenectady, N. Y.

The danger of glaring automobile headlights to motorists, to pedestrians and to the drivers of horse-drawn vehicles has long been apparent. Continued reports of accidents due to this cause show how great the menace is. How to overcome it has been one of the principal problems confronting those anxious to promote the safety of highway travel and reduce the shocking number of casualties that figure so constantly in the news columns.

A new lighting system for highways has been devised by the General Electric Company; and, tried out under exceptionally exacting conditions, it has proved a solution of the problem according to those who have observed its effects—and this number includes motorists, pedestrians, engineers and people living along the roadway where it has been installed.

Essential Feature of Lighting System

Its essential feature is a nest of three parabolic reflectors, one inside another, and with an opening in each reflector on each side of the Mazda lamp enclosed. Thus, the greater part of the light that would otherwise be lost by reflection upward, and outward to the neighboring fields, is collected and cast both ways along the highway. The inner reflectors pick up the rays of light that would escape if only one reflector were used, and direct them toward the surface of the road at an angle of 10 degrees below the horizontal, giving the same effect as an overhead reflector 15 ft. in diameter. The glare from the incandescent lamp is reduced by the white reflecting surfaces of the unit without the aid of diffusing globes. The bracket which holds the unit is adjustable either vertically or horizontally, so that the unit may be placed on poles near the roadway or some distance from it, and may be turned so as to illuminate curves and hillsides. This range of adjustment makes it possible to keep the opening in the lower part of the reflector parallel and in line with the surface of the roadway under any condition. The light may be thrown just where it is needed.

HIGHWAY ILLUMINATION ON THE ALBANY ROAD NEAR SCHENECTADY, N. Y.

Two Miles of Road Illuminated

This system has been installed along a section of the Albany-Schenectady state highway for a distance of about two miles

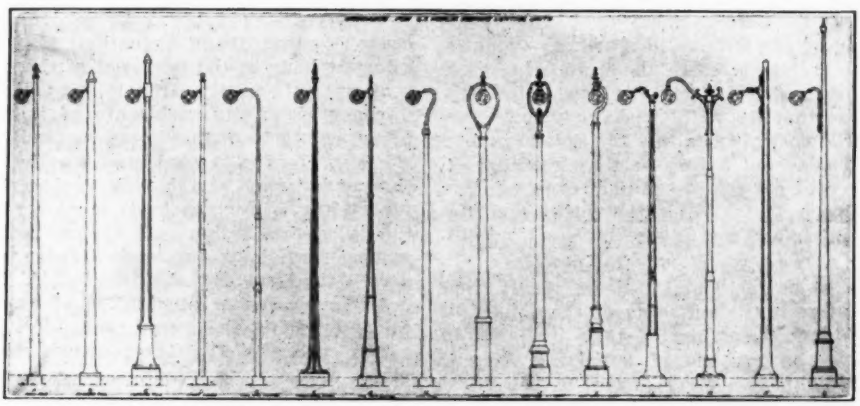
eastward from the Schenectady city line. The lamps are bracketed on poles, 30 ft. above the roadway, at intervals of from 300 to 500 ft., one 250 candlepower Mazda lamp, consuming 159 watts, being used in each fixture.

Travel over this road is very heavy. The highway is the main thoroughfare between Albany and Schenectady, and it is also a link of one of the great east and west routes of general tourist travel. Conditions are complicated by the fact that there is a large suburban population living along it, especially near the city lines, and the road is therefore much used by pedestrians. Casualties have been numerous among both motorists and pedestrians.

By the installation of this new system the highway lamps. Inside the house, with all the lamps in the house out, the rooms are flooded with light, very much as they would be when the moon is full—and it is only reflected light we get."

An eminent engineer, viewing the installation from the standpoint of a motorist and a citizen desirous of remedying the dangerous travel conditions of the highway, says of it:

"I have examined the lighting installation which has been made upon a section of the state road between Schenectady and Albany and want to express my opinion of the great value of this improvement, which, by a very simple, durable and inexpensive means, removes all the great dangers and inconveniences of night travel on this road where fatal accidents



VARIOUS STANDARDS FOR G. E. NOVALUX HIGHWAY LIGHTING UNITS.

the glare of approaching headlights has been eliminated. The roadway is so thoroughly illuminated that motorists can drive in perfect safety with the lights of their cars turned off. Pedestrians and approaching vehicles are plainly visible for a long distance, and the dark spot between two passing cars is eliminated.

Comments on Results Attained

Motorists who travel over this road, and persons living along it, are enthusiastic in their endorsement of the illumination. Two comments on it, made from different standpoints, are typical of the others:

"The lights are a great improvement," says a physician who lives in the territory traversed by the lighted section. "Only those who live out here and have been without lights can appreciate them. Sunday night it was pouring, but all the people coming from church walked out on the road and felt that it was perfectly safe to do so. I was able to read on the front porch of my house by the light from

have for years been of frequent occurrence, and where night travel has been a worry and a strain to all who have had to use it.

"This arrangement distributes the light generated by a small power consumption along the line of the road in such a manner that cars and people can be seen a mile ahead, so that it is as easy and safe to run without headlights as with them. Even the glare of headlights on approaching cars does not for a moment obscure the road or its borders. The addition of such lighting would increase the expense of construction and maintenance of a road by a very small percentage. The improvement afforded is certainly greatly in excess of such expenditure, and this lighting should be put upon every important highway, particularly where it runs through populous districts, as is very frequently the case near cities. The facility of automobile travel on these roads causes residences to be distributed along them

for many miles, near and between cities. The state highways are generally not provided with sidewalks and are used by many pedestrians at all hours."

Illumination Idea Is Spreading

The town of Colonie, near the eastern end of this installation, is so pleased with the result of this system that it has contracted with the Adirondack Light and Power Company for 30 of the units. One hundred units of this type have been ordered for a highway near Detroit. A similar system is in operation near Swampscott, Mass. Officials connected with the Ideal Section of the Lincoln Highway, which is to be built in Indiana, and which is to be made as nearly perfect a stretch of highway as can be constructed, have witnessed a demonstration of these lights and are contemplating installing them along the section mentioned. The engineer of the Bronxville Parkway Commission is interested in them, and they may be used for lighting the roads that traverse that beautiful park.

The cost of installing the system is low, and adds but a very small percentage—5 per cent or less in ordinary cases—to the expense of building the road, and the maintenance cost is small.

Important Incidental Benefits

Various incidental benefits result from it. One is the lessening of the danger of hold-ups. Another is that it helps to solve the problem of supplying current for light and farm power to the rural sections. Central stations which may not see their way clear to construct transmission lines for such territory on account of the expense, may find it entirely feasible to do so if the line can also be used to transmit energy for highway illumination.

That highway illumination is destined to play a very important part in the Good Roads cause is apparent, and the day seems already at hand when lighting will be considered a regular item in highway construction and maintenance appropriations.

SUPERPOWER PROJECT FOR REGION BETWEEN BOSTON AND WASHINGTON

A gigantic scheme for consolidating the generation and distribution of electrical power in the region between Boston and Washington is described in a report recently transmitted by Secretary of the Interior Fall to the President. The engineering study was conducted by the United States Geological Survey. The project aims to accomplish economy of fuel, labor and material in trasportation and industry. To connect all the large generating plants—both steam and water power—in one great system means more and cheaper electric current, because each ton of coal will be used to the best advantage and idle rivers will be made to turn wheels, especially in the regions farthest removed from the coal fields.

Looking Ahead to 1930

Looking ahead to 1930, with the increased demand for power that can then be reasonably expected, the total coal saved annually under the unified system will be 50 million tons. Under motor operation the industries could save $190,000,000 annually in their power bill and could make a greater output of product. The ordinary citizen also ought to profit directly by the superpower system because it promises a reduction of 1c a kilowatt hour in the first cost of the current as put on the transmission lines. Cheaper electricity and more of it will bring comfort to the home as well as efficiency to the workshop, even though the reader may search this engineering report in vain for any basis whatever for the pleasant vision of electric-heated homes throughout our land. Superpower does not stand for the impossible, but only for the wider application of practical engineering and sound economics.

The success of the Government's short-period study of so large a subject is due to the hearty cooperation, with the Government bureau selected to administer the work, of the engineering profession and of all the industries affected by the proposed larger electrification. Mr. W. S. Murray of New York, who had been the moving spirit in urging the advantages of a unified power system, was appointed chief of the engineering staff and promptly organized the work. An advisory board of business men representing the railroads and industries interested added driving force to the investigation and gave a larger practical value to the completed report, which is now published by the United States Geological Survey as Professional Paper 123. Secretary Fall has asked the members of this board to continue their public service in the further consideration of the legal and financial aspects of the superpower project, only the engineering features of which are presented in the report.

Why this Region was Selected

The North Atlantic coast region, to which it is proposed to supply more and cheaper electric current, was selected for

this study because its industries and railroads have the maximum requirements for power. Unfortunately, this region is not blessed with the abundance of water power that is possessed by the Pacific coast States, so that the plan of power production includes large steam plants at tidewater or on rivers large enough to furnish sufficient condensing water and hydro-electric power plants wherever they can be economically built on the rivers within the zone or within transmission distance of it. After 1920 cheap power from the proposed St. Lawrence improvement and from additional capacity at Niagara Falls may be available for Western New England and New York State, which will benefit greatly by the development of these new sources of energy.

Economy of investment and economy of operation are the two ends sought by this plan, outstanding feature of which is a great network of inter-connecting transmission lines which makes a system out of many units. "In interconnection is superpower" is the new version of an old adage, and here interconnection will mean 970 miles of 220,000-volt lines and five times that mileage of 110,000-volt lines. With these major lines, the 1,200 miles of lines now operated at 33,000 volts or more will become simply distribution lines for the local public utilities. This transmission network and its substations would require $104,000,000 by 1930, and the total investment cost of the system the same year is given by the engineers as $1,109,564,000, of which $693,218,000 would be new money, for more than $400,000,000 worth of existing steam-electric and hydro-electric plants are retained in service.

"Superpower"

Mr. Murray's use of the word "superpower" simply puts emphasis on the magnitude of the undertaking of furnishing electric power to the railroads and industries within the territory between Boston and Washington, an area that includes only 2 percent of the United States but that contains 22 percent of the total population. This region is in fact the most crowded workshop of our country. It contains 96,000 manufacturing establishments, 76,000 of which used power in 1919 to the amount of more than 12½ billion kilowatt hours. Nearly three-fourths of this power was generated by the industries themselves, largely in units of small capacity, with low efficiency as compared with the large units of the central stations of the electric public utilities. So it has been found that most manufacturing plants in this region can economically purchase power, and if they had purchased it in 1919 they would have saved 13½ million tons of coal. With the industrial growth expected by 1930 the complete electrification of the manufacturing and mining plants in this area would show an annual saving of $190,000,000 to the industries themselves above the fixed charges against an investment of $185,000,000 for motor equipment.

Railway Electrification

The 35 pages of the report devoted to the proposed electrification of the heavy-traction railroads presents results of even more general interest than the detailed analysis of the industrial use of electric power. The question of railroad electrification must be decided according to density of traffic, and so it is that of the 36,000 miles of main line, yards, and sidings in this superpower zone, only about 19,000 miles could be profitably electrified. This electrification would cost nearly half a billion dollars, but it would save from 11 to 19 per cent on the investment, or an average of 14 per cent. Electrification is the next step in railroad expansion absolutely necessary to increase both the capacity and the efficiency of our transportation system. Incidentally, the annual saving of 9,000,000 tons of coal by the railroads would greatly increase the available car supply. The report figures no returns resulting from the abolition of the smoke, cinders, and noise of the steam locomotives, but the ordinary citizen will find some comfort in the abatement of these nuisances.

This study of power needs is forward-looking and throughout expresses with confident American optimism the conviction that our industrial development is to continue without check. In this letter to the President, Secretary Fall refers to the obvious fact that it is by multiplying our man-power by machines that American labor can best meet the competition of cheap foreign labor. Secretary Fall also says:

"I believe the engineering facts and economic conclusions here presented will command the attention alike of the financiers, railroad executives, public utility officials, industrial leaders, and others of that large group of our citizens of large vision who are building for the America of tomorrow. Our present-day achievements have largely come through our country's unparalleled wealth in raw materials. The larger use of our sources of energy must be planned with every ef-

fort to avoid waste. Had the superpower project outlined in this report been in operation in 1919 it is believed that 25 million tons of coal could have been saved, and with the rapid growth expected in the present decade the saving possible in 1930 by the interconnected electrification of industries and railroads would be 50 million tons. However, these economies on a truly national scale will affect not only coal but capital expenditures as well, and especially the output of human energy. More and cheaper electricity must surely add to the comfort and prosperity of our citizens."

SUGGESTIONS ON THE DESIGN OF TILE DRAINAGE SYSTEMS

By J. W. Dappert, Consulting Engineer, Taylorville, Ill.

(Concluded from Sept. issue)

I have before me a table of "Drainage Co-Efficients," used by a firm of engineers in Southern Minnesota, in which is shown the drainage area in acres, sizes of channels and tile drains planned, gradients, and other data, and I am impressed with the quantity of run-off provided for. When I compare the quantities with those we have formerly used in Illinois, I begin to inquire if we have not been overlooking some of the very fundamentals of good drainage in Illinois. The table mentioned shows a drainage co-efficient of ⅝ in. for open ditches upon areas of 1,172 to 43,000 acres, 1 in. run-off upon areas of 1,100 to 20,336 acres, and 1½ ins. run-off upon areas of 3,850 to 9,545 acres, all in terms of depth of water to be drained off in 24 hours. For larger tile laterals the same table shows run-off provided for as follows: 1 in. upon areas of 7,300 to 5,000 acres; ¾ in. upon one area of 828 acres, noted as very flat; 1½ ins. upon one area of 3,400 acres; 1 in. upon one area of 8,166 acres, all in terms of depth of water to be carried off by the tiles in 24 hours. By persistent effort upon the part of the writer, some modifications amounting to 50% reductions were made before the final report was submitted, and even then the run-off provided for was unnecessarily large, requiring the use of much larger tiles than needed, thus doubling the already high costs of construction. I remark that if a run-off of from ¾ to 1½ ins. per 24 hours is required in Southern Minnesota, it is also required in Illinois, where rainfall is greater, and, if so, we have all designed our tile-drainage systems too small.

Mr. C. G. Elliott, in his Manual of Engineering for Land Drainage, gives a maximum run-off of 1.03 ins. per 24 hours for a district in Louisiana, where annual rainfall is twice as much as in Minnesota, and that is an extreme case, most of the maximum run-off even in the Southern states being less than ¾ in. per 24 hours.

Based upon experiences, after a trial of 25 years or more, I find that for most flat and moderately flat lands in central Illinois a run-off of ¼ in. per 24 hours is a reasonable figure to assume. If the areas are quite large, with considerable open ditch to convey floods, a quantity as low as ⅛ in. will be sufficient against which to provide. If the areas are small, surface drainage wholly deficient, as much as ¾ in. per 24 hours should be provided for. It is evident again that many variations from these figures might be proper, where the circumstances differ, and the engineer should make a close topographical survey and a keen, intelligent study of each tract of land designed to be drained, before arriving at his conclusions in the matter.

I find it convenient to have a table showing the run-off from areas of one to one million acres of land, in quantities of 1 in. down to 1/32 in. of run-off per 24 hours, said table being used in conjunction with a table of velocities and capacities of various sized tile pipes from 4 to 72 ins. in diameter, figured from Kutter's formula at gradients of from one-hundredth up to 1 ft. per 100 ft. Such tables can be prepared with a moderate cost in time and labor by calculating each fourth or fifth quantity from the formula and interpolating the others, or can readily be produced in the shape of graph.

To use such tables, having determined from the survey the area to be drained, its characteristics, and rate of run-off to be applied, the table of run-off quickly gives the quantity, which may be in gallons per minute or cubic feet per second, preferably the latter, which must be cared for upon the given tract. You now turn to the table of capacities and under rate of gradient available quickly find the size of tile which will convey as much as or a trifle more water than the run-off as determined. In making such table I generally use a value of N = .012 in Kutter's formula, for the best grades of drain tile, clay or concrete. I know that many engineers say that the value of N in such formula at .012 is too low, but my observation is that the assumption works out all right in a practical way,

and the tile drains designed upon this basis have performed satisfactory service. By means of tables, curves, or graphs you will readily proportion one drain with the other, and avoid making the capacities of the sub-mains and laterals combined much greater than that of the main drain, which often results where no calculations are employed.

Soil Tests, and Impervious Soils

Without considerable equipment it is impossible to make elaborate soil tests. The simple test as to quantity of water which a given soil will retain can be readily made by weighing the sample when fully saturated and again when thoroughly dry. The State University laboratories have made tests of most all soils found in the state, and when the engineer wishes to do so, and at a nominal cost, he can send in samples and have both mechanical and chemical tests made. The principal tests the drainage engineer cares for are mechanical relating to pore space, fineness of soil particles, voids, or water-holding space, and not so much the chemical composition. The soils which give up their waters most freely are those containing large percentages of organic matter, with large pore space, but they do not necessarily contain the greatest percentage of water. There is always left, even with thorough tile drainage, quite a large percentage of water in soils where tile drainage is required, and it is not the function of tile drainage to remove all but only the surplus water from the soil, or that which is injurious to plant growth.

There are some soils which are almost impervious to water. Frequently I have seen tracts of land which contained a surface soil of black, decomposed vegetable matter from 6 in. to 2 ft. in depth, underlaid with a very compact, impervious white clay subsoil. The sub-soil was somewhat of the nature of fire-clay or soap-stone, and by test, when cubes of it were submerged in a bucket of water for one hour or more, the moisture did not penetrate 1/32 in. deep into the cube. Where soils of this kind cover large areas of land I would proceed rather cautiously with the design of extensive systems of tile drainage. Usually, where found at all, the areas of this character are not large, and their drainage may still be effected by means of a system of catch basins and surface water inlets placed at the low places. Also, filling the trenches with top-soil, with a mixture of soil and vegetable matter such as corncobs, hay, or straw, will often result in the complete drainage of such areas.

I have even found it profitable to haul black top soil by wagons for some distance to treat a few exceptional cases of bad "scalds" of impervious clay. In soils of this character it is best to lay the tiles quite shallow, just safely below danger of frost and plow, and space the drains very near each other. The redeeming feature about tile drainage in soils of this character is that, gradually, minute run-ways are formed in the soil by action of the water, aeration takes place, and the tiles, if well laid, become more efficient every year.

Muck soils and gumbo such as are found in the American bottoms, along both sides of the Mississippi river in Illinois and adjacent to us, and such as are rather generally found along the lower stretches of the Illinois river, have all responded to tile drainage. It was not as rapid nor as effective at first as the tile drainage of the wet prairie lands in central Illinois, but after a few years the drains laid in muck and gumbo soils serve their purpose to remove the excess soil water just as effectively as those in the prairie soils.

Sand, Quicksand, and Soft Soils

Many instances of considerable difficulty have been encountered by reason of an unstable soil at or near the grade line of the drains, and a few instances are known where drainage projects were abandoned and waste lands allowed to remain so, by reason of the difficulties encountered in laying the drains in such places. In all these difficult places there is probably not one which could not have been surmounted by a skillful engineer. In some cases probably the cost would not be justified by the benefits derived, but more often than not it would be. These "bottomless pits" do not usually extend far in any direction and they may be bridged over by driving piles, cribwork, grillage, or some such method, and laying the tiles on top of planks fastened to the piles or crib-work. It may be best in some instances to cement the joints or use sewer pipe and make cement joints, lay the tiles in a bed of cement grout, or any of a dozen methods which any ingenious engineer may devise. Frequently the source of the excess water, as in the case of spring holes, may be tapped by a lateral or other drain, and when the excess water is prevented from reaching the "bottomless pit" or sink hole, it will gradlally dry up and admit

of easy construction of the drain through it.

Where much fine sand or silt is encountered at or near grade of tile drain, it is desirable to exclude it by some method. Wrapping the joints with jute, burlap, or any kind of cloth, straw, or hay is frequently very effective. Getting rid of the excess water by the method before described may also be a necessary part of the operation. The working end of the drain during construction should be kept free from water, as much as possible, and this may require the use of a trench pump operated by any motive power most available, even by hand labor if necessary. A wooden plug cut in size and shape to fit over the end of tile, having a few small holes bored in it to allow accumulating water to enter the end of a tile drain, should be kept constantly on hand to cover the tile during periods of suspension of work.

Bulk-Heads or Outlet Walls

This is usually the last work done in the construction of a system of tile-drainage. The money having all been spent in paying for tiles and labor, the outlet is allowed to go over to some other time. I have seen large systems of expensive tile drains laid, costing thousands of dollars, with not a thing done at the outlet beyond driving a stake or two to hold the end tile in place until the drain was completed. I have seen main tiles washed out for 40 rods above the original outlet, with a small canyon formed by erosion, of such age that timber and brush of considerable size grew along its banks. I have seen other tile outlets where thousands of dollars were expended in laying the tiles, and the outlets were so lost that they were hard to find in dry weather, and in one case completely buried by 2 ft. of soil over the top of a 12-in. tile at its outlet. When opened up and connected to a new drain, it ran almost full for two days, although very dry weather, and I know that system of drainage did very little effective work for some years previous to its repair. The method of repair is generally to go downstream for some distance to some available outlet in the same water course, build a massive concrete retaining wall, put a grate on or bars through the outlet tile, bring up the new drain, preferably outside the old open ditch, and join the old drain above the point where deposits exist in it.

In rare instances it is not possible to find a water-course or depression deep enough within a reasonable distance, to provide a clear outlet, and I have in a number of instances built a well of bricks, laid up in cement mortar, at outlet of tiles, dropped the grade of tile sufficiently to keep it well covered, as much as 3 ft. if need be, and let the water rise in the well to surface of ditch and flow away, using a grated iron catch basin frame and cover at top of well. I find that this method destroys from 20 to 30% of the effectiveness of the drain, depending upon the height to which the water must rise above the hydraulic grade line of the tile drain. It is a last resource, and ought not be employed where possible to secure a good free outlet otherwise.

The ideal outlet is into a small water course which does not overflow its banks greatly, but this is not always obtainable. The tile drain should be pointed somewhat downstream with the creek and located where a bank is rather high. The general plan may be a V-shaped wall or a straight face with two wings, a segment of a circle, or an L, depending upon the particular location of the work. It should especially extend as deep as bed of stream and be made massive enough to insure stability; the wings extending back into the solid earth helps to insure stability against toppling over. The tile pipe should be well cemented to the wall and have a grate over the end to exclude muskrats and other vermin. These grates are frequently made by drilling holes through the periphery of the tiles, about 2 ins. apart on centers, and inserting iron bars ⅜ to ½ in. in diameter, and it requires a rather patient workman properly to drill and fit such bars. There are patented gates and other devices upon the market, but none of them seem better or last longer than the iron rods, which can be replaced when they finally rust out.

Just below the tile outlet, joined to the base of the wall, an apron or platform should be provided to prevent the water from undermining the wall as it emerges from the tile. Where drop is considerable this apron should extend several feet and may require being a foot in depth, never less than 6 ins. thick. In several instances quite elaborate watering places for cattle have been made by paving the bed of the stream and making a large trough-shaped basin instead of such apron, out of concrete. I usually require a 1:2:3 mix in such concrete work, with no reinforcement, and the work is most frequently done by common labor. Supervision is not always possible, and a few failures have occurred,

due to not following the plans, the most usual deficiency being failure to go down to the depth required, because of the large amount of pumping required to keep the new concrete from washing out of cement. After one case of failure I measured a section of the wall which was presumed to be 18 ins. thick, and found it to be actually 2 ft. thick at top and but 7 ins. thick at a point 3 ft. below the top, and generally 7 to 9 ins. thick down to the base, which had not been put within a foot of where it was designed. The contractor was presumed to be a crook, so I appointed an inspector and instructed the contractor to let my inspector know when he started work, but the contractor hurried through the job, got it done without any inspection, and collected his bill for more than twice the yardage, after a casual inspection by the drainage commissioners. As the wall looked even more massive than the plans called for, and actually was at top 6 ins. thicker than necessary, the bill was paid freely, and the fraud discovered when the wall broke down during a flood several months later.

NEED OF SAVING NATURAL GAS

By Samuel S. Wyer, Consulting Engineer, Hartman Bldg., Columbus, Ohio.

There are over two and one-half million domestic consumers in the United States and more than ten million people are dependent on natural gas. Of all of the towns in the United States that have gas about one-half have natural gas; of all of the gas that is sold for public utility service about three-fourths is natural gas; of the 2,180 natural gas using towns in the United States 1,944 are too small to maintain manufactured gas plants, and it would not be feasible to build large central gas plants and pipe gas through the present natural gas transmission lines, therefore the smaller towns will be without gas service when natural gas is gone.*

Put Natural Gas Industry on Conservation Basis

There is no regeneration of natural gas and when it is gone it is gone forever. There has been a marked decline in production and the supplies available for future service are becoming less each year. The situation is acute now, will become worse each year, and the only thing that will permit continued service in the future is to place the entire neutral gas industry on a conservation basis, which means a marked curtailment in volume and a marked increase in price per unit of volume.

Natural gas is worth twice as much as manufactured gas in heating value. The flame temperature of manufactured gas and natural gas is, however, practically the same, but in ordinary domestic opertions the intensity of temperature is of no consequence, for what the consumer is interested in is not higher temperature, but a larger volume of relatively low temperature which is controlled by the heating value of the gas, and, as the heating value in terms of ordinary heating units is twice any manufactured gas that can be made, for all domestic purposes natural gas is worth twice as much as the average manufactured gas used.

Price of Natural Gas Must Go Up

The only way that natural gas service can be maintained in the future is to use the residue supplies that have been allowed to go to waste in the past. The fixed charges in a natural gas utility are larger than for any other public utility and represent about 70 to 73% of the income received from the public. These fixed charges go on regardless of the volume of business done, and this feature, coupled with increase in production cost, means that the cost per unit of volume will be greatly increased in the future if the residue supplies are to be secured, therefore the price of natural gas must go up—not because of the economical law of supply and demand, but because operating costs have greatly increased and only profitable operations will induce prospecting for new supplies. The live question is not how cheaply natural gas can be obtained but whether it can be obtained at any price to assure continuity of service for the future.

This increase in price must take place even if every other commodity price goes down. However, by carrying out the waste elimination recommendations of the U. S. Government, the consumer can pay the higher price per unit and still get the same service without any increase in the annual bill, due to the fact that intensive conservation can make one foot of gas do the work where three are now misused.

The Gas Waste

The gas waste in production, transmission and utilization has been enormous. At the present time, as an average for the entire United States, about one-third of the gas that starts to the ultimate consumer is lost in transit, due to leakage,

*For extensive discussion see Bulletin 102, Part 7—Natural Gas: Its Production Service and Conservation—Smithsonian Institution, Washington, D. C.

and of the 66% delivered to the ultimate consumer, on an average, the consumer wastes about 80%.* That is, while one-third is lost in transit more than three fourths of the remainder delivered is wasted by the consumer's inefficient method of utilization. The waste in the ordinary home will usually average about one-sixth of the total gas received. It is not ordinarily appreciated that leakage goes on continually—every hour of the day—and a leakage rate of only 1 cu. ft. per hour produces a loss of 8,760 cu. ft. in a year.

Much natural gas is still used in ordinary coal or wood stoves. Tests on stoves of this type show that 30 cu. ft. of gas is required to do the work that could be done by 6 cu. ft. in a correctly applied and properly adjusted gas range.

It was because of the acute general situation that the late Secretary Lane called a National Conference on Natural Gas Conservation in Washington, D. C., on Jan. 15, 1920. This conference resulted in the creation of a National Committee on Natural Gas Conservation, and resolutions were adopted by this committee to be carried out in every community.†

The State Superintendent of Public Instruction for the Commonwealth of Pennsylvania, Harrisburg, Pennsylvania, appreciating the vital interest of prolonging the supply of natural gas to the homes, authorized the use of a 16-page pamphlet on 'Use and Conservation of Natural Gas Especially Adapted for Use in Schools" in all of the natural gas using towns in Pennsylvania.

The State Director of Instruction in Geography is laying special stress on the outstanding features of natural gas in all of the geography classes, and the State Director of Home Economics Education is having all of the Home Economics teachers in the public schools teach the pupils how to cut down waste and thereby prolong the life of natural gas.

Waste in Distributing Plants

Much of the waste in distributing plants is due to the absence of accurate measuring data showing the exact relationship between input and output of a particular part of a gas transmission system. Many million dollars in property is destroyed annually in the United States by stray electric currents that have leaked off of or wandered away from defective return circuits of single trolley electric railroads. Much of this damage has been on underground pipes of natural gas distributing plants, and these stray current features have been an important means of increasing gas leakage and, therefore, waste. It would be to the public's interest that each municipality should make the local electric railroad responsible for its stray electric currents as well as for the protective measures that must be installed to protect underground property from the ravages of such currents.

Various substitutes for natural gas can, of course, be used, although they would all be much more expensive than even $1 natural gas. The equivalents for various competitive fuels per 1,000 cu. ft. of natural gas would be as follows: Manufactured gas, 2,000 cu. ft.; 200 lbs. of calcium carbide for acetylene; 9 gals. of gasoline; 8½ gals. kerosene; 15 gals. alcohol, and 322 kw. hours of electricity.

It has been shown by tests in cooking dinner, the fuel cost for the meal with five different fuels was as follows: $1 natural gas, 1.1c; $6.50 soft coal, 2.5c; 27c gasoline, 4.6c; 3c electricity, 5.1c, and 15c kerosene, 5.4c.*

Pressure Generally Too High

The pressures carried in most distributing plants are too high to have good service and municipal authorities should insist on lower and more uniform pressure. Very much better service can be gotten with pressures in the neighborhood of 2 ounces and not 4 ounces, and the distributing plant leakage will not only be much less but the consumer's combustion conditions with properly adjusted appliances for such pressures will be greatly improved.†

Recommended Conservation Measures

Municipal authorities working in the public interest ought, at once, to arrange for:

1. Reduction of stray electric currents to a point where they will not be substantially injurious to underground pipes so as to decrease the injury to the pipe and curtail leakage.

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*See Technical Paper 257—Waste and Correct Use of Gas in the Home—U. S. Bureau of Mines, Washington, D. C.

†Resolutions adopted by the National Committee on Natural Gas Conservation—June 11, 1920—U. S. Bureau of Mines, Washington, D. C.

*Kitchen Tests Relative Cost of Natural Gas, Soft Coal, Coal Oil, Gasoline and Electricity For Cooking—Department of Home Economics—Ohio State University—Columbus, Ohio.

†How to Get Better Service with Less Natural Gas in Domestic Gas Appliances—U. S. Bureau of Standards, Washington, D. C.

2. Attainment of the distributing plant leakage standard of 1,000 cu. ft. of gas per mile of 3-in. pipe, recently fixed as a fair standard by the United States District Court of Kansas.[1]

3. Lowering the distributing plant pressures and maintaining more uniform pressures. In all cases the pressures should be in the neighborhood of 2 ounces.

4. Should arrange for the gas company's inspection of all appliances so that the consumer would know what is right and what is wrong.

5. The prohibition of natural gas use in all coal burning appliances, since usually 3 ft. of gas are required in such appliances where only one would be required in the properly applied natural gas appliance for the same service.[2]

6. Prohibition of solid top low set burner cooking stoves. Grid tops only should be used and the burners should be about 1¼ in. below the cooking vessel.[3]

RELATION OF STREET LIGHTING TO TRAFFIC ACCIDENTS.

By Earl A. Anderson and O. F. Haas, Illuminating Engineering Staff, National Lamp Works of General Electric Co., Nela Park, Cleveland, Ohio.

The seriousness of the accident hazard on the streets of American cities as a factor to be reckoned with in every-day life becomes evident from even a casual inspection of statistics which show the losses incurred in this continuous waste of life, time and property. For example, in a recent paper Simpson[4] gave figures showing 25,000 fatal industrial and 2,000,000 total industrial accidents annually, causing lost time of a total cost of $2,000,000,000, or a cost averaging $1,000 per accident. The total annual fatal accidents from all causes, including industrial, are estimated to be 75,500 from statistics compiled by Dr. Crum[5], and of these approximately 7,800 are railway and 15,500 are street traffic accidents. Therefore the loss of life in traffic accidents is twice as great as in railway accidents and equal to over half the total industrial loss.

[1]Federal Reporter—Page 433.
[4]R. E. Simpson, Travelers Insurance Company—I. E. S. Transactions, Vol. XV, No. 8.
[5]F. S. Crum, Statistician, Prudential Insurance Co., Automobile Fatalities.
[2]For discussion of Governmental power to control this—see Amicus Curiae—"Can Preventable Waste of Natural Gas in Home Be Prohibited by Rules Authorized by Public Service Commission?" by Samuel S. Wyer, Consulting Engineer, Hartman Building, Columbus, Ohio.
[3]How to Get Better Service with Less Natural Gas in Domestic Gas Appliances—U. S. Bureau of Standards—Washington, D. C.

Automobile Accidents

As to an evaluation of the annual personal and property loss from automobile accidents in terms of money, Dr. Crum states that while an accurate computation is not possible, the annual sacrifice is fully $1,000,000,000. This figure appears very reasonable when one considers that in the survey of traffic accidents numbering 800 fatalities, reported in this paper, there are 31,000 other accidents of sufficient severity to be reported to the police, and that personal injuries were sustained in approximately one-half of these cases.

To the development of high speed traffic brought about by the very extensive adoption of automobiles must be charged practically all of the increase in street traffic accidents. In 1906 there were less than 400 deaths in the United States from automobile accidents, while in 1920 the total

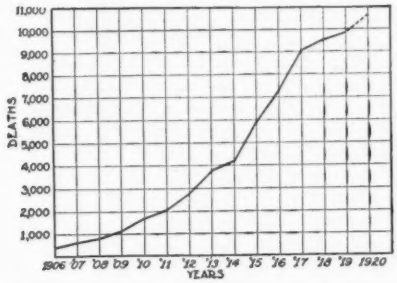


FIG. 1—INCREASE IN DEATHS FROM AUTOMOBILE ACCIDENTS IN UNITED STATES, 1906-1920.

was greater than 10,000, representing an increase of 2,500 per cent. Further, as shown by the curve of Fig. 1, this total is mounting steadily. In recent years efforts have been directed toward reducing the accident rate by more stringent traffic regulations and by widespread educational publicity work on the part of safety organizations. Definite evidence of the value of such safety measures may be seen in statistics which show a check in the growth of the accident rate in those cities and localities where the most careful attention has been given to the development of accident prevention efforts.

The figures presented by Dr. Crum show that at least two-thirds of all traffic accidents have occurred in cities of 10,000 inhabitants or more, and on this basis it would appear that the traffic accident problem is of greatest immediate importance in these larger communities. It is worthy of note, however, that the increasing amount of inter-city touring has

brought a heavy highway traffic to villages of even the smallest size, and it is, therefore, apparent that even in smaller communities public safety demands an increased attention toward means for reducing the street traffic accident hazard.

Proper Illumination a Factor in Prevention of Traffic Accidents

The purpose in instituting the survey reported in this paper was to obtain, if possible, some definite measure of the value which should be attributed to the proper illumination of streets as a factor in the prevention of traffic accidents. In order to obtain as high a degree of uniformity as possible in the collection of the data, blank forms were prepared providing for a charting of all traffic accidents in a given city during the period of one year and for distributing them as to the month and hour of the day at which each occurred, with notations as to whether or not the accident resulted in a fatality. A representative group of cities was selected and individuals in each who were known to be interested in problems of public safety were requested to arrange for the tabulation of the data. The work of tabulating accidents from the city records was often tedious on account of the way in which the accident reports were filed. In some instances the accident data were not available. The very cordial response to the request for cooperation in this survey is, however, attested by the fact that tabulated reports in form to be directly applied were obtained from 32 cities with a combined population of over 7,000,000. From each of these cities the report covered a full year's accidents; in most cases during the period from the middle of 1919 to the middle of the year 1920. The names of the cities and an abbreviated summary of the tabulation for each city is given in Table 1. The total number of street traffic accidents reported for one year in these 32 cities was 31,475, of which 9,534 or 30.3% occurred during hours of darkness. It was anticipated that there might be considerable variations in conditions existing in individual cities located in different states, and it was, therefore, particularly desired to obtain a sufficiently diverse group of cities, including a large enough total of population to give the presumption of a reasonable degree of accuracy in the results.

FIG. 2—EFFECTIVE STREET ILLUMINATION AS ILLUSTRATED BY EUCLID AVE., CLEVELAND, OHIO.

This Famous Street is Lighted by 1,500-Candlepower Mazda Lamps in Ornamental Lanterns Spaced 85 ft. Apart.

Monthly Variation in Accidents

The 31,475 traffic accidents are charted in Fig. 3, according to the total number during each month. In certain cities special local influences, such as an excess of traffic at some one season of the year, changed the distribution of accidents considerably, but in most cases the individual reports adhered to the trend shown by the average curve in Fig. 3. At first thought it is somewhat surprising to note that there were a greater number of accidents in the summer months than in winter, as there are a number of influences which tend to increase the hazard in winter, such as stormy foggy weather, slippery

streets, and the impediment of heavy clothing. However, as a matter of fact, the traffic is so much greater during summer months than in winter that even in spite of the unfavorable conditions in winter the accidents are more in the summer than in the winter months in most cities.

Hourly Variations in Accidents

The total accidents reported for the year are charted in Fig. 4, according to the hour of the day during which they occurred. This chart also shows the apparent importance of density of traffic as a factor in causing accidents. It will be noted that relatively few accidents are reported in the hours from 1 to 7 o'clock in the morning, the period of the day in

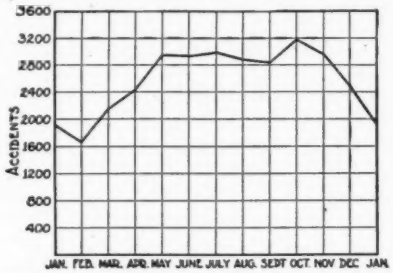


FIG. 3—DISTRIBUTION OF TRAFFIC ACCIDENTS BY MONTHS.

which street traffic is least. On the other hand, the accident rate becomes greatest in the hour from 5 to 6 in the afternoon, when in practically every city the streets are congested with the home-going population from offices, stores and factories.

An obvious and simple way of determining how many of the 9,534 accidents which occurred after dark would have been avoided had daylight or its equivalent been available, is to compare the accidents which occurred during the hours in the evening which were daylight in summer with the number of accidents which occurred during the same hours in winter, when, because of the shortness of the day, it was dark. Consultation of tables of sunrise and sunset applying to the different cities involved indicated that the hours 6 to 8 p. m. were the two hours of the day which are fully light in the months of May, June and July, and entirely dark during the months of November, December and January.

It is evident, however, that a ratio between the accidents occurring from the hours 6 to 8 p. m. in summer as against the number that occur during the corresponding hours in winter would not directly show the influence of light because of the numerous other variables referred to above which have an influence that must be taken into account.

Fortunately the accident statistics for the hours of the day which are light in both summer and winter or which are dark, in both summer and winter, offer a convenient means for determining a correction factor to take into account the variables other than light which affect the number of traffic accidents in winter and summer. The periods of 3 to 5 p. m. and 9 to 11 p. m. are the logical selections because of their adjacency and the consequent similarity of traffic to that in the 6 to 8 p. m. period. In Table I there is shown a tabulation by cities and the totals of accidents for the respective periods of 3 to 5 p. m., 6 to 8 p. m. and 9 to 11 p. m., separated so as to show the number of accidents during these hours in the summer months of May, June and July, and the winter months of November, December and January combined.

Referring to the totals in Table I, and taking first the hours from 3 to 5 p. m., which are daylight in both summer and winter, the numbers of accidents are found to total 1,429 in summer and 1,095 in winter. The winter accidents from 3 to 5 p. m. are, therefore, 76.6% of the summer total. Considering next the totals for the period of 9 to 11 p. m., which is dark both in summer and winter, it is noted that the accidents are respectively 740 and 495. The winter accidents from 9 to 11 p. m. are, therefore, 66.9% of the summer total. If these two percentages of 77.6 and 66.9 are averaged it is indicated that for the group of cities in this

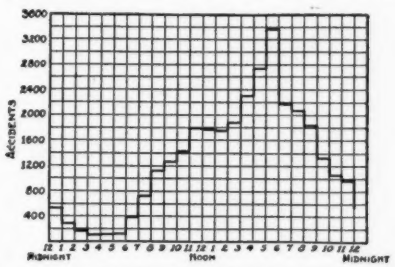


FIG. 4—DISTRIBUTION OF TRAFFIC ACCIDENTS ACCORDING TO HOUR OF THE DAY.

survey, traffic conditions are such that, excluding the influences of illumination, the winter accident rate in the afternoon and evening is approximately 71.8% of the summer accident rate.

Considering next the period of 6 to 8 p. m., which in summer is daylight, Table I shows a total of 1,200 accidents in the

32 cities during the three months of May, June and July. Hence, applying the average percentage of winter to summer accidents (71.8%) determined as above* it would be anticipated that in the three winter months of December, January and February there would be 862 (71.8% of 1,200) accidents during the hours of 6 to 8 p. m. However, the survey shows a total of 1,046 accidents to have actually occurred during these hours in the three winter months or 184 more than anticipated provided there had been the same effectiveness of illumination in the winter months as in summer. Hence, there is the strongest evidence that 184 accidents or 17.6% of all those at night must be attributed to the lack of light during the winter months. Applying this same percentage to the 9,534 accidents which occurred after dark in the 32 cities covered by this survey, it appears that 1,678 would have been avoided if adequate illumination had been provided.

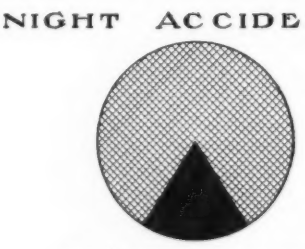


FIG. 5—SURVEY INDICATES THAT 17.6 PERCENT OF NIGHT TRAFFIC ACCIDENTS ARE ATTRIBUTABLE TO LACK OF SUFFICIENT ILLUMINATION.

Accidents Attributable to Poor Street Lighting

Assuming that the same proportion of day and night accidents which was found to exist in this survey holds in all cities, last year there must have been out of the total of 10,640 killed 3,223 deaths from night automobile accidents, and 17.6% of these, or 567 were, therefore, directly attributable to lack of sufficient illumination. In addition to this loss of life, a similar computation shows that the very substantial amount of $54,000,000 of the billion dollar annual street accident loss estimated by Dr. Crum may also be attributed to lack of light. According to census reports the total expenditure for street lighting in the United States is not in excess of $50,000,000.

Poor Lighting May Cause 50 Percent of Night Traffic Accidents

The percentage of 17.6 arrived at as the proportion of night accidents which may be attributed to lack of light is undoubtedly an extremely conservative figure to use in evaluating the usefulness of illumination in preventing traffic accidents, for, as a matter of fact, the streets of all of the cities covered in the foregoing survey were illuminated at night by artificial lighting of varying degrees of effectiveness. In an individual city where the need for better street lighting is especially evident the percentage of night accidents chargeable to the lack of light is likely to run as high as 50%. On the other hand, in the case of those districts where fairly high levels of artificial street lighting are provided by so-called White Way systems, the percentage of night accidents chargeable to lack of illumination can be said to be fairly low. It was hoped to have data from this survey to show the difference, but it was not found practical to separate the statistics for the better lighted sections in a sufficient number of cases to arrive at an average figure.

While in the present state of the art it is not practical to provide artificial street lighting approaching actual daylight levels, it is entirely feasible to increase the quantity of light to a level from 3 to 10 times higher than that provided by average existing systems, and when this is done with properly installed equipment it may be confidently expected that a large measure of the benefit of light in reducing accidents will be secured.

It is, perhaps, pertinent to emphasize that these higher levels of artificial street illumination, the expenditure for which is so amply justified as an accident prevention measure, have many other important advantages in contributing very greatly to the prevention of crime, to the comfort and convenience of all those traversing the streets, and to commercial and industrial progress.

Growth of Night Traffic Will Call for Better Lighting

Modern illuminating engineering has been of great assistance economically in making possible "double shift" operation of industrial plants, thereby in many cases reducing the overhead charges on the investment in plant and machinery by

*The percentage for 6 to 8 p. m. actually is probably nearer the 9 to 11 p. m. figure of 66.9% than the average of 71.8% since both periods are during the evening hours. However, the more conservative figure is used. Had 66.9% been used, the computed percentage of accidents due to lack of light would have been 23.3%.

as much as one-half. In the development of a level of street lighting such as will enable night traffic at the same density, speed, convenience and safety as by day, there is offered a similar important opportunity for community economy. Large as the expenditures are already for improved thoroughfares and highways, engineers estimate that at the present rate of traffic growth duplicate roadways must be built very soon in many districts. This congestion, however, will be greatly relieved and the time when duplicate road construction is required will be postponed for years in many cases provided a larger proportion of the traffic can be diverted from the crowded day hours. In line with this Mr. Arthur Williams of New York recently presented a paper in which reductions as great as one-half in trucking cost were estimated to be possible by the increased utilization of equipment and terminal facilities and the avoidance of traffic delays by the use of streets during the less congested night hours. It is apparent that the density of traffic which would result from such a "double shift" utilization of thoroughfares and highways would greatly increase the total of night accidents. Furthermore, the greater density of traffic at night would undoubtedly result in a larger proportion than 17.6% of the accidents being chargeable to lack of light unless adequate street lighting is provided. But the annual cost to the community of lighting entirely sufficient for safe and convenient night traffic is small indeed compared with the construction and maintenance cost of the additional roadways which will otherwise be required.

The foregoing paper was presented before the Illuminating Engineering Society, September, 1921.

"MIXPEN" BITUMINOUS CONCRETE.

By Geo. A. Henderson, Consulting Engineer, of International Bituconcrete Company of Delaware, St. Albans, W. Va.

Many articles on bituminous pavements have recently appeared as a result of the increasing popularity of bituminous foundations which have been demonstrated, by more than 20 years heavy street traffic in the opinion of many engineers, to have many features superior to foundations of hydraulic concrete.

Notwithstanding this there seems to be very little change or improvement in such bituminous structures over those built many years ago. It is the purpose of this

TABLE I—TRAFFIC ACCIDENT STATISTICS FOR 32 CITIES DURING A PERIOD OF ONE YEAR

	TRAFFIC ACCIDENTS REPORTED									
					3-5 P. M.		9-11 P. M.		6-8 P. M.	
	Total	Night	Total Fatal	Night Fatal	W'ter*	Sum.	W'ter*	Sum.	W'ter*	Sum.
Philadelphia, Pa.	5231	1485	190	66	175	251	71	98	164	183
Cleveland, Ohio	3549	1059	174	56	120	120	89	73	154	121
Boston, Mass.	3380	1001	89	38	108	159	57	69	117	131
Pittsburgh, Pa.	2950	982	6	2	119	183	57	100	74	109
San Francisco, Cal.	3014	1092	76	32	127	106	58	73	110	84
Jersey City, N. J.	672	223	28	13	18	38	8	17	36	32
Rochester, N. Y.	2570	735	29	9	70	111	34	71	62	119
Portland, Oregon	1230	411	31	8	45	43	11	21	38	48
Columbus, Ohio	193	95	17	9	7	11	6	13	8	7
Hartford, Conn.	1389	300	19	6	38	72	12	17	37	57
Grand Rapids, Mich.	255	78	12	4	9	8	1	7	10	12
Youngstown, Ohio	702	258	33	15	33	31	12	17	28	25
New Bedford, Mass.	699	189	7	3	34	40	6	17	20	31
Lynn, Mass.	818	278	7	2	35	40	19	20	36	42
Utica, N. Y.	652	150	9	3	22	43	2	25	16	33
Fort Wayne, Ind.	1010	241	9	2	42	30	14	13	29	19
Peoria, Ill.	131	26	7	3	5	11	1	1	5	1
South Bend, Ind.	143	46	6	3	6	6	5	6	7	5
Portland, Maine	620	177	1	..	16	24	9	16	20	18
Charleston, S. C.	192	52	13	3	6	8	..	7	8	3
Rockford, Ill.	181	45	11	3	5	15	3	5	3	9
Saginaw, Mich.	120	48	3	..	..	7	2	3	8	5
Holyoke, Mass.	287	79	5	2	15	13	5	2	5	15
Gary, Ind.	281	78	10	4	5	11	3	13	6	12
Malden, Mass.	187	56	3	..	3	9	..	5	3	13
McKeesport, Pa.	74	30	2	..	1	1	1	3	2	6
New Castle, Pa.	74	31	3	1	3	2	..	5	2	12
Mt. Vernon, N. Y.	264	78	2	1	11	12	3	7	8	12
Evanston, Ill.	287	81	9	4	7	17	2	7	6	11
Austin, Tex.	169	75	2	2	9	3	2	2	16	9
Muskogee, Okla.	42	20	2	..	..	3	1	1	2	9
East Cleveland, Ohio	109	35	6	4	1	1	1	6	6	7
Total	31,475	9534	821	298	1095	1429	495	740	1046	1200

*Winter refers to November, December and January.
Summer refers to May, June and July.

article to refer to some of the present possibilities in this direction.

Mixing and Penetration Methods

In the more expensive "mixing method" of producing "bituminous concrete" the mineral ingredients of coarse and fine aggregates are carefully graded and then mixed with a normally semi-solid bituminous binder in a power mixer when all of the ingredients have been sufficiently heated to remain hot while being separated as to sizes of the mineral aggregate, mixed with the bitumen, hauled to the road and there spread and compacted over its cold base.

In the less expensive "penetration method" for producing "bituminous macadam" the cold stone in *situ* in the road is coated with a relatively light bituminous material (more of a lubricant than a binder) that can be rendered sufficiently fluid to penetrate into its voids.

The bituminous cement used in the mixing method when of consistency about 50 to 60 penetration, represents its maximum binding value in bituminous structures and is in itself of greater inherent stability than that bituminous material used in the penetration method, which is generally of from 125 to 150 penetration, as tested for consistency, and of minimum binding value.

In the mixing method, scientific grading of the aggregate, and the comparative density and stability of the viscous binder, are relied upon for stability, whereas in the penetration method mechanical clasp of the larger sizes of compacted aggregate, wth stone screenings for filler of the voids, is relied upon for the structure's stability more than is any binding function of the penetration material.

On the other hand, if the mixing-method binder be used in the penetration method of construction, it would prematurely congeal upon being spread over the cold stone in *situ* before penetrating its interstices, and would form a surface mat which would peal off in time.

Efforts to Combine Advantages of Mixing and Penetration Methods

Efforts to combine the economy of the penetration process with the superiority of the product of the more expensive mixing method have included the following:

It has been proposed to "cut back" the heavy mixing method bituminous cement with about 50 per cent of naphtha, and rely on evaporation of the latter, in time, to leave the heavy binder in the aggregate's voids where it is deposited by using the naphtha as a carrying agent; but on recent tests such a structure has been found to be more or less porous and absorbent (like hydraulic concrete) when the naphtha (like the water of portland cement mixtures) is evaporated from the mass of which it was a part; and, too, the cost of the naphtha, so temporarily used, is economically prohibitive.

In the writer's experiments he has temporarily liquified such a 50-penetration bituminous cement chemically, and during escape of residual gases to the atmosphere on impinging under pressure the binder into the interstices of previously heated and absolutely dustless aggregate unfilled with stone screenings in *situ* on a road, he has succeeded in completely filling its voids with the semi-solid bituminous cement; but due to lack of grading of the aggregate (as in the mixing method) so that the smaller particles will, as nearly as they may, fill the voids between the larger ones, it is found that notwithstanding the normal mechanical clasp of the larger aggregate, the pavement still lacks that inherent stability of the mixing method, the interstices being filled exclusively with pure asphaltic cement, the most expensive ingredient of a bituminous structure, which forms "lakes" in the voids, and during hot weather, softens.

The "Mixpen" Process

With these basic conditions in mind the "mixpen process" has been finally evolved by Reiman G. Erwin, chemist; H. K. Stephenson, engineer, and the author, from a combination of the mixing and the penetration methods, in which a mastic is employed, consisting of 50-penetration bituminous mixing method cement in which 50 per cent of its weight of clay dust is colloidally suspended when the bituminous material is temporarily reduced to a state of liquefaction by the interaction of sulfurous gases in the presence of traces of moisture under the influence of agitation and heat above the boiling point of water, which results in a constantly changing cellular or honeycombed condition of the mass, on the thin films of which the dust is separately lodged in steam suspension, and the mass then completely dehydrated before passing, while still in a gaseous condition, through penetration nozzles of a pressure distributor in which the entire mass is constantly agitated by the ordinary asphalt pumps. Notwithstanding the stiffening influence of the dust particles present, it is found that they, (while colloidally suspended in the molten bitumen, so temporarily reduced to the fluidity of

water chemically), are carried in *gas* suspension, until, in passing under about 40 lbs. pressure to the square inch, from the nozzles to the road's surface, all gases and vapors escape to the atmosphere on impinging of the mastic within the open, heated, dust-cleared interstices of the larger aggregate in *situ*, forming a matrix of greater inherent stability than the trap rock aggregate it fills and binds.

The heating of the larger mineral aggregate in mixing-method bituminous concrete is essential to secure the greatest bonding efficiency of the asphaltic cement to the aggregate, when dry, in addition to the necessity for such a degree of heat as to maintain the mix sufficiently hot until spread and compacted over the cold base. If the latter were not true the mere *surface* heating of the stone would be sufficient to secure the bond of the matrix to the larger aggregate. In the mixpen method the 1½ to 3-in. macadam stone compacted in mechanical clasp is not filled with screenings or other filler, and the pressure distributor of the mastic above described is equipped with a surface heater, using fuel oil heat mixed with hot air, which is blasted into the interstices as the distributor passes over, to be at once followed by the penetration nozzles on the same machine, within 1 ft. distance of the surface heater's operation. Whatever dust may be left in the larger aggregate's interstices is removed not only by the hot air blasts above mentioned but by severe suction from the surface heater's hood, which suction in volume is equal to the pressure of the hot air from the burners under the hood, thus avoiding lateral suction or pressure at the hood's sides.

The chemicals used to accomplish the above purpose *benefit* the bituminous cement when that cement is the product of asphaltic base petroleum of oil refineries as distinguished from the "natural asphaltic cement" such as Trinidad. This benefit results from exact duplication, both physically and chemically, of Trinidad Lake asphaltic cement both from the same mother substance—asphaltic base petroleum—from which the Trinidad, as well as the "artificial oil asphalts" are all derived, viz.: It is now incontrovertibly determined and recorded in the foremost text books on the subject that: (a) the bitumen of Trinidad is the residuum of asphaltic base petroleum of identical characteristics to that available from oil wells on Trinidad Island, in Mexico, in California and elsewhere, and refined in our local refineries by the volatilization of kerosene, naphtha and the other lighter oils therefrom; (b) that this petroleum deposit at Trinidad is treated by nature in her laboratory set up in the crater of a *constant* volcano that is today active, by subjecting it to volcanic heat in the presence of clay dust mixed with salt water infiltrated thereto from the sea; (c) that sulfur (of identical nature to that available in Louisiana) is by nature provided, and that when all of these ingredients are subjected to sufficient heat hydrogen sulfid and sulfur dioxide *gases* interact chemically on the hydrocarbon (the bitumen) to reduce that residuum of the oil to a constantly changing cellular condition on the very thin films of which the widely dispersed clay particles are found to be separately lodged in colloidal suspension upon complete dehydration of the mass. All Trinidad pavements in use today are made from asphaltic base petroleum containing almost uniformly 38 percent of non-asphaltic matter, towit: clay dust in particles even larger than those locally available throughout the United States, in which local deposits the particles by elutriation tests of the writer have been found to be capable of passing a 200 mesh, 60% smaller than .02 millimeters in gradations down to smaller than two microns.

It is not questioned by any authority that the sulfur content of Trinidad asphalt renders it more tenacious, more ductile, more cementitious, and tougher than such asphaltic residuum containing either that sulfur known to the art of vulcanizing or containing no sulfur at all. It is likewise a fact that the sulfur content of Trinidad asphalt is entirely different and has a different effect on petroleum residuum than the sulfur heretofore used in even rubber vulcanization can have on the bitumens or rubber. This is due to the now demonstrated fact (as last year disclosed by Professor Peachey of the Manchester [Eng.] College of Technology) that those sulfur "derivatives" of Trinidad, viz., hydrogen sulfid and sulfur dioxide *gases* interact on vulcanizable materials to vulcanize them almost instantly (in the nascent period), even in the cold.

It is also generally conceded that to the extent truly impalpable mineral dust can be colloidally suspended in any heavy bituminous binder, is inherent stability and density of the pavement of which it forms a part, and its durability increased. It is likewise conceded that

by all methods heretofore known not more than 10 percent of such truly colloidal dust can be so suspended in a mixing-method bituminous cement. While Road Oil will permeate dust, the heavier mixing-method bitumen is found to be in films too thickly surrounding the *separated* particles of microscopic size so to suspend more than 10%, and to the extent any particles are not separated by the bitumen in a pavement is that structure weakened. Hence, except in the case of nature's Trinidad product, all United States standard specifications prohibit the use of more than 10 percent of such truly impalpable filler, and permit that only in the presence of fixed proportions of grains of larger sizes "to take care of the dust."

The subject of colloidal chemistry, being that of bubbles, particles, films and filaments, and that of dispersed colloids, a state of matter as distinguished from an amorphous form, would require a too-technical discussion to be briefly presented here, and it is sufficient to say that in its relation to the provisions of a dense tough mastic forming a matrix binding together an ungraded aggregate in bituminous concrete, the electrical forces that are believed to be present and finally responsible for colloidal disperse of molecular particles, have added to them at Trinidad Lake, and now artificially in the "mixpen" specification, further electrical forces in the form of soluble salts, viz., sodium sulphate, sodium chloride (both present in nature's Trinidad process) and sulphate of copper, and without knowing or claiming any specific chemical reactions on the bitumen, but observing the result of these artificial additions to the sulfuretted bituminous residuum of asphaltic base petroleum, as at Trinidad, reliance may be had on these salts in the formative period of the mastic to sustain such colloidal condition of the particles therein; and further, because of such stiffening influence of the mineral dust, and the sulfuretting of the asphalt, the product representing its mastic, as distinguished from pure asphalt, filling the voids in the *ungraded* aggregate is hardened and is less susceptible to heat and cold without reducing its ductility, to the extent of producing a denser mass of more inherent stability than even the mixing-method bituminous concrete, the reductions in costs of which are due to reducing the quantity of asphalt by using the local dust, the ease and rapidity of placing ungraded, unheated, unfilled, compacted, cold aggregate on a subgrade and then heating, dust-clearing and filling with mastic all voids by the less expensive penetration method.

RE-PLANNING RICHMOND, CALIFORNIA

By Guy Wilfrid Hayler, City Planning Engineer, 1743 Bush St., San Francisco, Calif.

One of the widest schemes of civic improvement west of the Rockies has been proposed by the City of Richmond, California. On Oct. 14, 1921, details of a comprehensive City Plan were laid before the City Planning Commission by Messrs. Carol Aronovici and Guy Wilfrid Hayler, Associated City Planners, who have been engaged on the work for some months.

Characteristics of the City

Richmond is a city of only 20 years' growth and has now some 16,000 inhabitants. It is essentially industrial and is the western terminal of the Santa Fe Railroad and the location of an extensive branch of the Standard Oil Company.

Its situation is on San Francisco Bay almost opposite San Francisco and the Golden Gate and has a backbone of hills on the water front for some distance, a wide stretch of marsh land and a swampy area close to deep water out of which the United States Government has planned to create a harbor.

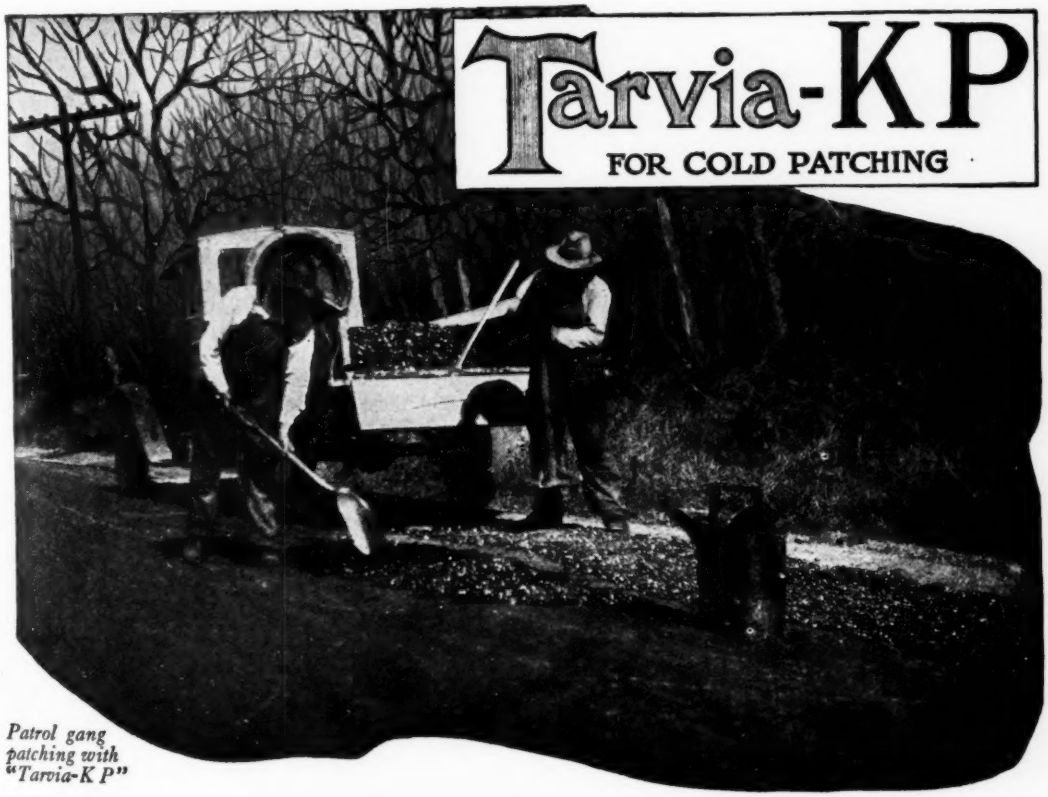
The city itself has grown eastward from the water front hills and now covers the plateau which extends up to the foothills of the Contra Costa range. Few city sites are so varied and the problem of development, whether residential, industrial or transportation has been further complicated by real estate exploitation which has laid out streets regardless of everything except immediate profit.

The city now finds itself a scattered community covering 29 square miles with inadequate thoroughfares, unnecessary grade crossings, no parks or playgrounds, no centralized business area, small school playgrounds, insufficient transportation facilities, remote public offices and a general confusion of residential, industrial and railroad locations.

Special Maps Prepared

The work of replanning has necessitated a civic survey of an exhaustive character and maps have been prepared which detail the following phases of the city:

1. Existing conditions, showing how land and property is now used, industrial locations, open areas, public property, rail-



Patrol gang patching with "Tarvia-K P"

Winter Maintenance Saves Spring Repairs—

It's expensive to neglect your roads through the winter—to abandon them to the freezes and thaws that ravel the surface and play havoc with the foundation. As a matter of fact, proper maintenance is even more important in winter than in summer.

Here's an easy, inexpensive method of maintenance that is being used by experienced road officials all over the country:

Before the snow comes—they patch the road surface with "Tarvia-K P." Then, from time to time during the cold weather, they do whatever further patching becomes necessary. (Tarvia-K P can be used whenever the roads are free from snow.) As a result they not only have good roads all winter, but they avoid a lot of expensive repair work in the spring.

"Tarvia-K P" is generally recognized as the most economical, efficient, and convenient-to-use of all road-patching materials. It can be employed on hard roads of every type. It is mixed cold and applied cold. And as the "mix" does not deteriorate with age and is uninjured by freezing, it may be made up in good-sized batches for use as required.

An illustrated booklet giving full directions for repairing different types of roads with "Tarvia-K P" will be sent on request. If you have any troublesome problems in road construction, maintenance or repairs, the Special Service Department will gladly help you solve them. Please address the nearest office.

New York Chicago Philadelphia Boston St. Louis Cleveland
Cincinnati Pittsburgh Detroit The Barrett Company New Orleans Birmingham Kansas City
Minneapolis Dallas Nashville Syracuse Salt Lake City Seattle
Peoria Atlanta Duluth Milwaukee Bangor Washington
Johnstown Lebanon Youngstown Toledo Columbus Richmond
Latrobe Bethlehem Elizabeth Houston Denver Jacksonville Buffalo Baltimore Omaha
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road property, schools, etc., together with charts of wind direction, ratio of land and water in city area, relative proportions of land occupancy in the city structure, etc.

2. Distribution of population showing the growth of Richmond since incorporation and density of population expressed by dots. Charts of populational increase and city territory increase are also given.

3. Waterfront and harbor showing the proposals of the U. S. Government for the new Inner Harbor, industrial development of the waterfront, wharfs, landings, ferries, etc., together with the hydrography and topography of the shore line. Charts of land, water and marsh areas, public and private tidelands are added.

4. Public utilities showing the complete sewer system and outfalls, water mains and wells of the various companies, gas lines and source of supply, electrical power cable lines, substations, etc. Charts show the extent of the public utility service in relation to the homes and population.

5. Improved streets showing all paved streets and type of paving used. Charts show the ratio of paved to unpaved streets, proportions of the various types of paving, etc.

6. Major thoroughfares and transportation facilities showing all railroad tracks, grade crossings, industrial spurs, depots, freight houses, switching yards, grade eliminations, ferry lines, street car routes, auto stage lines, motor truck lines, together with the major thoroughfares outlined in relation to the regional districts. Charts show length of transportation lines, major thoroughfares, traffic census figures in graphic form embracing the flow of vehicular traffic at important points, etc.

7. Land values showing the present values of developed and undeveloped land on a front foot and acreage basis, also the value of tidelands in private ownership. Charts show in detail the rise and fall of values in the business district.

Preliminary City Plan Prepared

In addition to these maps which have formed the groundwork for the city planning studies by Messrs. Aronovici and Hayler, a preliminary City Plan has been prepared which outlines the recommendations for improvements. These cover:—(1) New major thoroughfare system. (2) New boulevard system. (3) Proposed new streets. (4) Street widenings. (5) Streets abandoned. (6) New parks. (7) New school extensions. (8) Railroad neutral freight right of way. (9) New street car routes. (10) Sites for new public buildings. (11) Civic Center development. (12) New zoning scheme for the city.

Outstanding Proposals

Amongst these proposals the following stand out as conspicuous. The new major thoroughfares which give arterial access and unite business districts, industrial areas, waterfront, railroads and main regional roads. Considerable attention has been given to this subject because of the future prospects of Richmond becoming a still greater industrial center and the need of facilitating the conduct of business on the most efficient lines. The new boulevard system which creates a tree-lined girdle around and through the city, will make the thoroughfares attractive to the regional motorists and encourage them to visit Richmond, as well as providing enjoyable drives for the citizens and promenades for the people. At present the city is almost destitute of trees, although there is every reason to believe they would thrive here.

Recreation is amply provided for, a large city park, small parks with field houses, an aquatic park on the waterfront and small plazas throughout the city being outlined. In addition there are many school playground extensions as well as the outline of a new high school with large athletic stadium. The City Planners have shown in detail how such recreational areas may be developed.

In line with other progressive cities Richmond is much interested in zoning and a scheme for zones for residence, business, light industry and heavy industry is submitted, with outlying areas where marsh and hilly topography at present render unusable, remaining unclassified until land reclamation and development has brought them into the influence of the city.

The City Planning Commission has tentatively accepted the recommendations of the City Planners, and the preliminary plans for improvements. Instructions have been given to have these placed before the citizens at mass meetings for their approval. A wide scheme of publicity will be given to the proposals with the hope that an early commencement may be made to achieve realization. The City Planners were highly complimented on the plans which will be placed on public exhibition as well as being reproduced by photographs and lantern slides.

WATER WORKS SECTION

SOME FEATURES OF PRESENT WATER SUPPLY PRACTICE

(Editor's Note: The following excerpts from the 1921 report of the Committee on Water Works and Water Supply of the American Society for Municipal Improvements contain much valuable comment on the latest developments in the water works field. Mr. Nicholas S. Hill, Jr., consulting engineer, 112 East Nineteenth street, New York, N. Y., is chairman of the committee.)

Pumping Machinery

In no branch of water works engineering have greater changes developed in the last few years than in the design and selection of pumping machinery. The first really successful water works pump was the direct acting steam pump. Henry R. Worthington, the father of the modern pumping engine, brought out the first of this type of pumps about 1840. The year 1895 marked the introduction of the duplex direct acting pump and various improvements resulted from the efforts of such men as Blake, Knowles, Cameron, Marsh, Dean and others.

The use of steam pumps on a large scale began about the year 1860, and the crank and flywheel pump appeared about 1868. Various other improvements followed, which were principally improvements in details of the mechanism of the pump. No really fundamental change in design occurred until 1876 when the Corliss pumping engine made its first appearance and proved to be a success. Steam was now being used expansively with a marked increase in economy. Duties by this time had risen from around 50 thousand foot pounds per 1,000 lbs. of steam to around 120 thousand foot pounds per 1,000 lbs. of steam. It was quite logical that the steam pump should follow step by step the development of the steam engine with corresponding improvements in economy.

All of the pumps up to 15 or 20 years ago installed in water works plants were of the reciprocating type, either direct acting or crank and flywheel, or either vertical or horizontal pumps as the case may be. The term "reciprocating pump" covers all pumps in which the water is displaced by a plunger, piston, or bucket, working back and forth in a cylinder. The past 15 or 20 years marks the development of the centrifugal pump, although in 1680 the first centrifugal pump was built,, and 1818 was the year when the first crude pump of this type, called the Massachusetts pump, was built in this country. It is probable that the centrifugal pump did not come into general use because of the fact that it is a relatively high speed machine and there was no motive power well suited to it, but with the introduction of the steam turbine and electric motor, conditions have changed. These high speed machines stimulated the development of the centrifugal pump and we now find an ever-increasing demand for this type of machinery.

Probably another reason for the delay in demand was due to the low efficiencies of the earlier types of centrifugal pumps, but at the present time turbine driven centrifugal pumps of large capacity have been installed in water works plants which have produced duties of from 135 to 165 million foot pounds per 1,000 lbs. of steam as compared with 170 to 180 million for the best types of reciprocating engines.

When the low first cost of the turbine driven centrifugal pump is taken into consideration, it makes a very attractive proposition for large water works. In small isolated water works the electrically driven centrifugal pump offers many inducements, and there are to be found now many installations of centrifugal pumps which are driven by producer gas engines, oil engines of the Diesel type, and gasoline engines. The tendency toward centrifugal pumping machinery is notable and marks a step in the evolution of water works design.

Rainfall and Runoff Records

The source of all water supplies, whether surface or underground, is the precipitation of vapor from the atmosphere, commonly known as rain, but also in the frozen forms of snow, sleet and hail. These last are eventually reduced to water and the recorded quantities of

snow, sleet and hail are expressed as equivalent water. Part of this precipitation is re-evaporated into the atmosphere. Another part falls directly on the water surface of lakes, swamps or streams. Some is transpired by vegetation and a portion runs off directly from the ground surface. The remainder enters the soil. Surface waters and subterranean waters feed the water courses at various distances from the point at which the rain falls.

All of these actions take place at irregular intervals, varying in duration and may be much extended, except that direct or surface runoff is generally limited to relatively brief periods, which vary with the topography, geology, geographical location and physical conditions of the watershed and its cover, as well as with the season and climate.

A knowledge of the amount of runoff in various localities and on various watersheds is absolutely essential to the proper design of dams and reservoirs. One of the great difficulties which the water works engineer had to contend with in the past was the absence or paucity of suitable rainfall and runoff data. Great strides have been made in maintaining gauging stations for the purpose of recording the runoff of streams in various parts of the country. These have been of invaluable assistance in the proper and secure design of water works. Few people recognize the value of maintaining rainfall and runoff records. We beg to call its importance to the attention of the municipal officials and to request that they encourage the maintenance of such records in the states in which they live, and of water works officials a request is made that they maintain such records on the watersheds under their jurisdiction and control.

Works for the Collection and Distribution of Water

No great changes have occurred in the design of structures for the collection of water, which include the dams and aqueducts, within recent years, except that concrete, as in every other line of engineering endeavor, has replaced other forms of masonry. Much more care, however, is exercised in the design of dams than was formerly the case, and a greater factor of safety is required than in times gone by. The failure of large dams in this country developed public opinion to a point where it demanded legislation requiring state supervision of dam construction and this has resulted in better design, workmanship and material.

Cast iron is still the stable material for the fabrication of pipes for water distribution in cities and towns, although wood stave and wrought iron and steel pipe are occasionally used in transmission lines. Great strides, however, have been made in the design of the details of the distribution system, including the design of hydrants, valves, corporation and curb cocks and the like, but probably the greatest strides have been made in labor saving devices which have been developed for use in connection with the maintenance of the distribution system. The making of connections under pressure and the insertion of valves without cutting off the water, and other operations of like nature, have greatly facilitated the work of the water works superintendent.

Because of the high price of iron and steel, the use of concrete, particularly for tower tanks and pipes, has increased. Some of these structures were poorly designed and built and discredited the material. However, refinements in the mixing and placing of concrete as well as greatly improved methods for making it impervious to water, have brought it into the reliable class.

For the past few years, maintenance and necessary extension only has been the motto of water authorities, but a period of more active construction is approaching rapidly. Work on the new supply for Providence has been resumed. Large purification projects are under way at Milwaukee, Cambridge, Kansas City and Detroit, while in general the undone work of the war time is only awaiting a stabilized labor market for its doing.

Standards for Water Quality

Standards of quality are steadily rising and bid fair to continue doing so. Communities no longer consider safety sufficient, but demand a drinking water of good appearance. This demand has good scientific foundation for the best appearing waters are frequently the safer.

In certain sections, the northeast particularly, waters having colors of 25 or more are still used without complaint. These colors would not be tolerated in western cities supplied with lake or filtered river water, or even in New England; public opinion is fast getting in a position to demand water of an average color of 10 parts per million or less with a maximum of 15. Particular objection is made to colored surface waters containing odoriferous organisms; and turbidity, whether due to heavy microscopic

growths, to clay, or to iron rust, is also objectionable.

While the bacteriological standard of the United States Public Health Service met with considerable criticism because of its alleged severity and because it excluded certain water supplying communities in which good public health conditions prevailed, it can not be denied that those who are aiming to supply waters of high quality are trying to equal or better this standard which, as is well known, commands that all waters used in inter-state commerce shall contain no gas-forming organisms (presumably B. coli) in at least three out of five portions of 10 c. c. from the sample tested. One reason for this appreciation is the improvement in public health diagnosis; this, in turn, to better vital statistics, better organization of the health authorities and refinements in clinical methods.

Quite recently the significance of certain spore-forming bacteria (B. Welchii, B. Aerogenes and B. Enteriditis), when found in water, has been the subject of much discussion especially in connection with the outbreaks of intestinal diseases, other than typhoid fever, at Shreveport, La., and Montclair, N. J. These spore-forming organisms are more resistant to the action of chlorine than B. coli and other non-spore-forming organisms and are apt to exist in surface waters which have been chlorinated but not otherwise purified or imperfectly purified by rapid filtration. Both the nature of these organisms and their relation to disease are as yet known imperfectly, and Sir Alexander Houston has recently expressed his opinion that the B. coli should still be regarded as the criterion for classifying waters with regard to their connection with gastro-intestinal disease.

Water Softening

Rain water, which is initially pure and soft, acquires mineral constituents as it percolates through the soil, and the mineral content of water, therefore, depends upon the character of the soil and rocks through which the water has percolated before it is tapped into the source of supply. Therefore, hard water is to be expected in countries where limestone, dolomite, sandstone, gypsum and glacial deposits are found. From these and similar sources soft rain water is converted into more or less hard water. Hard waters are objectionable in many ways. For domestic and laundry use they require large quantities of soap. They are unsatisfactory for washing because they have a deleterious effect on the finer fabrics. They are unsatisfactory for bathing because they have an annoying effect on the skin. They increase plumbing bills because of the formation of scale in waterbacks and piping. For boiler use they cause trouble by forming scale in the boilers, which shortens the life of the boilers and fire boxes and increases the bills for fuel and repairs. In certain special industrial processes hard waters are considerably less satisfactory than soft waters, and they can not be used in certain processes, such as bleaching and dyeing establishments.

It is likely, therefore, that the increasing competition for industrial growth and the rising standards for domestic water supplies will lead to a substantial growth in water softening. The need for water softening does not depend on sanitary grounds so much as on economic grounds. The hardness of the water has little or no effect upon the public health, but for both industrial and household uses hard water is unsatisfactory. In particular, the quality of municipal water supply for industrial purposes assumes importance where towns are competing for the location of industrial plants. Many towns depend upon railroad shops and round houses, or large manufacturing plants, for a considerable proportion of their population. The progressive city with an ample supply of soft water will grow while others will stand still. There is a more direct economic appeal, however. Under certain conditions, depending upon the hardness of the water, the size of the town, and other local considerations, the residents of a town will save money by softening its water. The relation between the cost of water softening and the saving resulting therefrom to the ordinary householder is very direct, and in many cases the saving in soap alone is sufficient to pay for the cost of softening, to say nothing of the saving in damage to the finer fabrics, the reduced cost of plumbing, etc.

There is an increased demand for softened water, particularly in residential districts and in textile dry houses and bleacheries now supplied with hard water. In addition to the limesoda process in use for 70 years, artificial zeolites, of which "Permutit" and "Delcalco" are trade examples, have had widespread use in the industries, in hotels and large residences, and are beginning to enter the municipal field. By their use, water may be completely softened, the calcium and magnesium in the water exchanging with the sodium in the zeolite. After the zeo-

lite becomes exhausted, it is regenerated by contact with brine, followed by washing with water.

Water Supply and Disease

Among the worthy accomplishments of the past decade has been the reduction in the typhoid fever death rate in American cities; another was the remarkably low typhoid death rate among the American Expeditionary Forces, a marvelous contrast to the records of the Spanish and Boer Wars. For example, the typhoid death rate of Massachusetts for 1920 was 2.5 per 100,000 and only five of the cities of that state had rates exceeding 5 per 100,000, a glaring contrast with conditions of 15 years ago when leading sanitarians were talking of "residual" death rates much higher than these actual accomplishments.

Notwithstanding these improvements in the public health, due in largest measure to improvements in water supplies by storage, inspection, filtration and disinfection, the goal is not yet reached. Mild outbreaks of gastro-intestinal disease, like a mild type of dysentery, rarely causing death, appear suddenly in many municipalities, especially in the spring, and the distribution of disease is such that the public water supply has seemed in each case to be the cause. The necessity for vigilance and study still exists and the well-known lines of defense against water borne disease must be well supported, for without watchfulness the best designed works may fail, as evidenced by the recent outbreak of typhoid at Salem, Ohio. Material assistance may be given to the water department by the community by destroying infectious material at its source, and by better use of the methods of hygiene and preventive medicine.

Water Purification

Both the advantages and limitations of storage as a method of purification have been the subject of recent discussions—the consensus of opinion being that it is a valuable and perhaps the most reliable single method, but not free from the danger of wilful or accidental contamination.

There have been few changes in the basic design of water purification plants within the past 10 or 15 years, but many improvements have been made in the details of water purification plants, particularly with respect to the pipe galleries in gravity mechanical plants, with respect to the handling and application of chemicals, and other practical matters. The use of the hydraulic pump to mix chemicals with water by J. W. Ellms, in the Milwaukee experiments, seems to be a simple and effective substitute for the older methods of baffled channels, agitators, weirs and other mixing devices.

Where filtration and softening are combined, difficulties resulting from the so-called balling-up of the filter sand, due to the accretion of lime deposits on the sand grains in the filter beds, are being overcome by several methods which have been developed recently.

The knowledge of the handling and application of chemicals used in the treatment of water has been vastly benefited by the researches of physical chemists in recent years.

The difficulties of treating colored waters and waters of low alkalinity to produce an effluent free from color, turbidity and colloidal aluminum hydrate, and one which would not erode or corrode service pipes and plumbing, are well known. While many operators have surmounted the difficulties connected with the purification of such waters, they have done so by methods largely empirical; it was difficult to find a scientific basis for proper treatment or reasons for failure. Recently, however, water chemists have made use of the hydrogen ion concentration, and the method bids fair to explain much which is now obscure.

Briefly, the hydrogen ion concentration is a measure of the reaction of the water, of its acidity or alkalinity, but it is a delicate and discriminating measure and gives information which the ordinary alkalinity determination does not. By hydrogen ion concentration is meant the concentration of disassociated or active hydrogen in the water. The standard alkalinity determination measured the total amount of alkali present, but it did not measure the concentration, either before or at any stage in its neutralization. The determination of the hydrogen ion concentration gives by difference the concentration of the alkalinity at any time, and this is a factor that is often of very great importance to know and which may throw a great deal of light on proper application of chemicals in water purification plants. We will not attempt a technical discussion of hydrogen ion concentration at this point, but simply wish to call attention to the benefits which may result from this method of measuring the re-action of the acidity or alkalinity of water.

Our more progressive officials are beginning to realize that water purification is not only a problem of hydraulics and

mechanics, but a problem of chemistry and biology as well, and are giving more encouragement to laboratory work. It is unfortunate that very little attention has been given to the laboratories at water purification plants in the past. The larger plants have had well equipped laboratories from the beginning, and expert chemists and bacteriologists were employed to carry on the routine analyses necessary for the proper operation of such plants, but very few of the smaller plants maintained properly equipped laboratories and fewer still had anyone connected with the plants who had a fair knowledge of chemistry or bacteriology. This practice is fraught with much danger for the reason that the existence of a filter plant gives a feeling of security to a community, whereas a filter plant without proper supervision may be but a blind to camouflage a really critical situation.

Fortunately, however, at the present time boards of health in many cities, and particularly in many of the states, are taking a hand in the supervision of water purification. It has become necessary for the water departments to report to the health boards the result of their chemical and bacteriological analyses. This has resulted in the establishment of laboratories in nearly all except very small plants. Closer attention is given to the results obtained for the health departments are also testing water. In some states the supervision of filter plants has gone so far as to require all operators to be licensed. The State of New Jersey, so far as we know, has been the pioneer in this respect. On February 9, 1918, an act was passed relative to the examination and licensing of operators. This act authorized the State Department of Health to examine prospective operators and to issue a license, providing the examination of the applicant proved him to be capable of performing those duties which would be required of him. It is further provided that every purification plant must have a licensed operator. This is a step in advance and should result in better filter plant operation.

It is to be remembered, however, that the licensing of operators and the making of daily routine analyses are not all that is required. The water works superintendent should give greater attention to the analysis of the water supply under his charge. Analyses are useless unless used, and this observation is true with regard to all operating data in a water works plant. The mere collection of the data is not sufficient. It must be used and applied.

Electrolysis

Ever since the advent of the street railway, water works plants throughout the country have complained of electrolysis of mains and service pipes. The term "electrolysis" embraces the entire process of accelerated corrosion of underground metallic structures due to stray currents.

The practical electrolysis problem is due to stray currents from electric street railways. Instances of stray currents from other sources sometimes occur, but such cases are rare and are not specifically considered.

Electric currents straying to earth from electric tracks frequently find their way to water and gas pipes, telephone and power cables, and other underground structures. When this current leaves these structures through earth, corrosion results. Thus not only are the structures of many different companies subject to injury, but by reason of the different public services dependent on such structures, the public as a whole has a direct interest in this type of electrical interference.

As the investment in pipes and service connections in the towns and cities of this country is enormous, the added depreciation resulting from electrolytic corrosion represents a large economic loss to the municipalities of the country. Suits were brought in several instances to compel the street railway companies to modify or change their system of operation or to secure damages for electric corrosion. No definite beneficial results were obtained from these studies for the reason that the data were not sufficient on which to base a determination of the minimum residual amount of stray current which was permissible and which would not cause injury to underground metallic structures nor whether it was feasible for the street railways to keep the stray current down to this minimum residual.

Believing that the matter was subject to co-operative treatment the American Committee on Electrolysis was appointed. This committee consisted of representatives of the electric railway, electric light, telephone, gas and water interests. Already one report has been made on the subject of electrolysis and a second report will be issued within a short time. It is to be hoped that this committee will be continued and that the results of its work will be to bring about a better understanding of the problem of electrolysis prevention and a closer co-operation be-

tween the electric interests and the interests which maintain the structures affected by electrolysis.

It has been found advantageous to form joint committees composed of technical representatives of the several utilities concerned to investigate the local electrolysis situation and determine by agreement the course of procedure to be followed. Such committees should, of course, attack the problem in an open and fair minded manner with the object of effecting mitigation in the most economical way. To this end they should be composed of men, or have men associated with them, who are trained in the technique of electrolysis. Active committees of the kind described are now existent in Chicago, Kansas City, Omaha, St. Paul, New Haven, Milwaukee and Syracuse. The principle of co-operation has been recognized by the Railroad Commission of Wisconsin in an order authorizing an electrolysis committee in the State of Wisconsin. Such committees act as clearing houses of information and keep all of the interested companies informed as to changes in their systems which may affect the electrolysis situation. Under the direction of such a committee joint electrolysis surveys may be conducted and unified methods of mitigation installed and maintained.

MODERN METHODS OF CARRYING BOND ELECTIONS

By R. E. McDonnell, of Burns & McDonnell Engineering Co., Consulting Engineers, Interstate Bldg., Kansas City, Mo.

As a basis for bond elections, municipal officials usually adopt the method of employing a consulting engineer who makes his preliminary plans, estimates of cost, and report on the project. The carrying of the bonds is then usually left to the city officials, who with the aid of civic organizations, endeavor to interest the voters in support of the project.

Successful Modern Methods

The failure to carry many worthy projects has caused the writer to adopt modern methods which, upon trial, have proven so successful that it is believed they could with profit be adopted by any city having a bond election under consideration. Bond elections in growing communities are necessary, once in about every three years, and in one state last year over one hundred bond elections were held. It is a waste of time, money and energy to place any bond issue before the public without fully informing the voters of every phase of the project, such as feasibility, first cost, and cost of producing the commodity, whether it be water, electricity, gas, heat, or ice. Operating costs, fixed charges, revenues, and rates to be paid often decide the fate of bond issues.

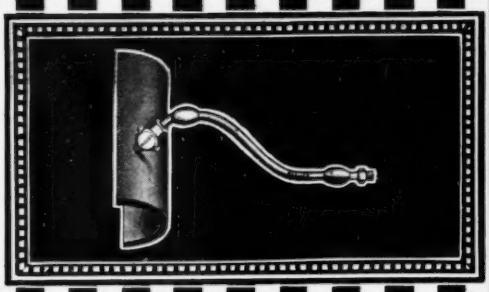
Carrying Bond Elections an Engineering Problem

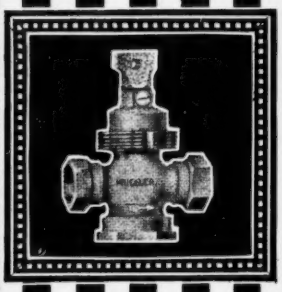
After 25 years' engineering experience in solving municipal problems, the writer is convinced that the carrying of bond elections is an engineering problem and should be handled by the engineer as a part of his duties, rather than that the burden be shifted to city officials, whose offices are political and where supporters of the administration must be appealed to. Many partisan voters, or "outs," decline to enthuse on a bond project because it is advocated by the "ins." An engineer is employed to handle the work because of his special engineering training and skill, and, having no political ambition, his advice, suggestions and recommendations "listen good" to a great majority of citizens who find politics and good municipal utilities don't mix. Votes for bonds are no longer secured by appeals of oratory to "Support the administration," "Have confidence in them, they will spend it honestly," "Show pride in your city," "Our old run-down utilities are a heritage of the last administration," and similar phrases, but nowadays the voters question and analyze the operating and maintenance cost, the upkeep, life of material, etc., and must be shown wherein they are going to be benefited. This critical and proper analysis by the voters, whether men or women, requires a different campaign, and it must be one of education about the engineering problems involved. To prepare a fine set of plans, or a beautifully bound report no longer satisfies. The job, or bond issue, must be sold to the public and the buyer, or voter, wants facts, figures and absolute proof that the investment is a profitable one for himself and his home town.

Handling Water Bond Campaign at Parsons, Kans.

A successful bond campaign for a half million dollars for rehabilitating the municipal water works plant at Parsons, Kansas, has recently been conducted by our engineering organization and the methods used are outlined as an example of what other cities might accomplish by adopting similar methods.

Preliminary plans, maps, estimates and summaries of the report were prepared on a large scale for use in window displays.





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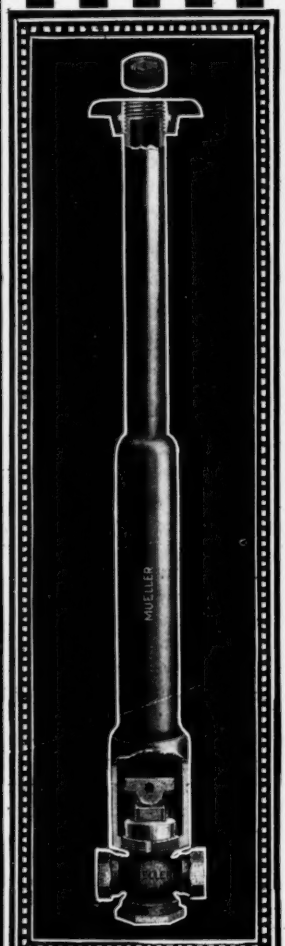

About 75 stereopticon slides were made and used at mass meetings and before civic organizations. Municipal band concerts were held outdoors and following the concerts all features of the project were explained—cost estimates, operating expenses, depreciation allowance, bond sinking fund, revenues and rates, with net income, were shown through graphical diagrams. All engineering features were so clearly explained that a prominent attorney, commenting on the project, said: "The engineering is shorn of its technical features and we are now all engineers and see the soundness of the whole project."

Newspaper Cooperation

"The Parsons Sun" expressed a willingness to publish a series of water works articles, which were prepared by the engineers. These articles were run daily, many of them being illustrated by views showing both the present conditions of the water works system and the proposed improvements. Over 50 of these articles were prepared and used. They were written, not as a technical journal would use them, but as newsy, interesting items. To test their power to interest readers, an interruption was intentionally made which caused many 'phone calls of inquiry and request for the articles to continue. Some knowledge of the 50 articles may be gained by quoting some of the titles: "Why the Women of Parsons Want Pure, Soft Water," "How Good Health Can Be Purchased," "What Happens When a Water Famine Occurs," "The Cost of a Typhoid Epidemic."

Facts and Figures Used

A feature of the improvements was a modern water purification system to displace a very inadequate and antiquated system. Comparative figures were given showing the saving in cost of operating a modern plant, thus showing the voters that they were daily losing money by operating an inefficient plant, besides giving the city an unsafe water to drink. Former bad fires were illustrated, with tables of annual fire losses, showing the fire loss per capita far above that of other cities. Insurance rates were shown to be exorbitant because of the present inadequate protection. Fire losses due entirely to poor pressure were shown to exceed the total bond issue asked. A portion of the improvements consisted of replacing a large amount of small steel and wrought iron pipe, also replacing a flow line of spiral riveted steel and vitrified pipe. The leakage figures were given, showing a loss of over half the water pumped. Exhibits of this worn out pipe were placed at prominent street corners with placards giving age, when removed, etc. The per capita cost of the Parsons proposed improvements was shown to be less than that of about 25 cities similarly situated.

The generation of electricity for operating low service pumps over a ten mile transmission line to the River Station and also low service pumps at the City Station, lighting the grounds, stations, etc., was a part of the improvements strongly opposed by a private company, wanting to sell electricity to the city. This feature involved a fight for municipal ownership with all its advantages to be shown by the engineers. The salesmen with something to sell in the way of machinery, equipment, pipe, oil engines, steam engines, etc., were very active, making it necessary for the engineers to make an unbiased report on each, and thus forestalling opposition to the bonds.

Speaking Campaign

The publicity campaign through the papers and by personal presentation of the plans before civic organizations continued for four weeks, with an intensive speaking campaign for 1 week, when 21 meetings were addressed, in explaining the engineering, economic and health features of the project. Noon meetings were addressed when factory, shop and office employees were reached. Slides were daily distributed to all the picture shows, showing some special features of the improvements. Local speakers were organized and 10-minute talks at all picture shows were made during the closing week. Church announcements were made calling attention to the necessity of good citizens voting either for or against, but leaving them to form their own conclusions.

The women voters, through the Parsons Federated Women's Clubs, sponsored the final mass meeting, bringing before the women voters the importance of the water supply from the standpoint of health, hygiene, sanitation, beautiful lawns, clean streets, swimming pools, school and street drinking fountains, etc.

Various business men co-operated and jointly carried full page advertisements recalling former water famines, bad fires, and showing what the new improvements could offer in the way of securing new industries in Parsons.

Home owners were clearly shown by figures that not a dollar of taxes would be added, but that the revenue would make the plant self-supporting.

Attitude of Engineers Conducting the Campaign

The engineers conducting the campaign

2-inch Service Pipe cast bell down in 9-foot lengths

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Bell and Spigot Joints

One engineer has stated that nothing will ever reduce the loss of water through leakage in distributing systems so much as the general adoption for services of cast iron pipe with joints that will stay permanently tight. Exactly this type of pipe is offered in U. S. Cast Iron Bell and Spigot Service Pipe.

In most cities the service pipe is laid by regular water works employees who are perfectly familiar with lead-poured bell and spigot joints. So that this type of installation results in a very tight line which, at the same time, has all the flexibility of a regular bell and spigot main.

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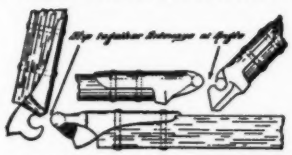

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had the support and active aid of the mayor, but no aid or co-operation from one of the commissioners, and the active opposition of the other commissioner, until two days previous to the election, when his conversion occurred and the three united in a printed statement favoring the bonds. Other early opposition gradually melted away as the project became understood and those who had opposed came out in print favoring the bond issue. In their articles and talks the engineers refrained from directly urging the voters to support the bonds, but took the position of a disinterested consulting physician to a sick utility, and presented their prescription for the patient in the form of plans, estimates and report, and all features of these were clearly explained, leaving the voters to form their own conclusions whether they wanted to vote for or against the bond issue.

Results Secured

The prescription offered was taken, the bonds were carried, and the half million dollar improvement is now being carried out under the guidance of the engineers, with the expectation that the sick utility will soon be restored to health.

The engineers have found from experience that the same character of bond campaign is applicable toward any municipal problem. It has recently been successfully applied on bonds for sewage disposal, electric lighting, and municipal ownership of several utilities. Its success confirms the belief of the writer that real engineering goes farther than the mere preparation of plans, but that the engineer should "put over" the projects instead of leaving them in the hands of laymen to scramble.

THE WATER DISTRIBUTION SYSTEM

By H. R. F. Helland, City Engineer, City Hall, Waxahachie, Texas

In the construction of the water distribution system it is very important that an accurate record be kept of valves put in and connections made, said Mr. Helland in addressing the 1921 meeting of the League of Texas Municipalities. Much valuable time and a great deal of trouble will be saved by having the correct locations of valves and connections. For example, in making a new map of the water works in Oklahoma City, Mr. Holloway, superintendent, found numerous instances where valves shown on his records had never been put in and he found valves in the lines of which there was absolutely no record. In one instance he cites nine valves had to be closed and five miles of main shut off in order to repair a broken main, when, if his old records had been correct, it would have been necessary to close only two valves and shut off one mile of main.

In this connection, provision should be made for the periodical inspection of valves and fire hydrants. A valve or a fire hydrant is of no use unless it is in good working order. A leaking valve can be detected by means of an aquaphone.

The records of valves should show, besides giving the location, the number of turns necessary to open or close. Knowing this, when testing a valve it is easy to tell whether the valve is operating correctly. It sometimes occurs that when opening or closing valves a workman, thinking that the valve is not open, exerts extra pressure on the valve wrench, thus twisting the valve stem in two. By knowing the correct number of turns necessary to open or close, this can be avoided.

A few months ago I found it necessary to repair a hydrant in one section of Waxahachie. We closed, or thought we closed, the two valves that it was necessary to operate, but found that quite a stream of water was still coming through. Had these two valves been in good condition, only two blocks of main would have been shut down. As it happened, it was necessary to close three additional valves and put eleven blocks of main out of service. It was found upon examination that the valve stem of the defective valve had been twisted in two with the gates only partly closed. A periodical operating of the valves of the system will also prevent to a great extent the corrosion and clogging of the valve seats. In the same way, a defective fire hydrant is worse than useless, valuable time being lost by trying to operate such a hydrant in case of a fire.

Meterage

Every city should be 100% metered. It is now recognized that the only proper way in which to sell water is by use of meters. There is as much sense in using the flate rate system as there would be in paying your grocer a certain amount each month regardless of what you used. A meter correctly measures the amount of water delivered to the consumer and the meter reading should govern the amount the consumer pays. The water once having passed through the meter belongs to the consumer and has been delivered to him, and should be paid for regardless of what becomes of it.

Water Works Equipment Service

If in the market for any of the following water works equipment, so indicate by check marks, mail to *Municipal and County Engineering*, Indianapolis, and price quotations and descriptive literature will be forwarded to you.

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—Derricks, Steel Portable
—Drinking Fountains
—Dry Feed Chemical Apparatus
—Engines, High Duty
—Engines, Gas
—Engines, Oil
—Engines, Pumping
—Explosives
—Fence, Iron
—Fittings, Wrought
—Filter Equipment
—Gates, Sluice
—Gauges, Recording
—Gauges, Steam
—Gauges, Water
—Goose Necks
—Hydrants, Fire
—Indicator Posts
—Lead
—Leadite
—Lead Furnaces
—Lead Wool
—Leak Indicators
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—Lime
—Meter Boxes
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—Motor Trucks
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—Oil, Lubricating
—Pipe, Cast Iron
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—Pipe, Wrought Iron
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—Pumps, Deep Well
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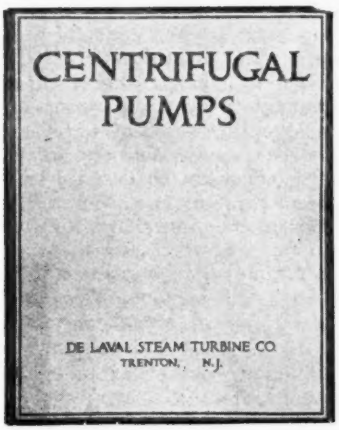

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I do not believe in making adjustments for excessive bills or leaks. It is a responsibility of the consumer to keep his piping in good order. If water is wasted it is not the place of the water company to bear that loss. A flat rate leads to the waste of water and experience has shown time and again that the water consumption is materially reduced after a system has been fully metered. When a meter becomes old and worn, it will under-register and in practically all complaints that a meter registers too much it will be found that the consumer has had a leak on his premises.

Large Feeder Mains

In laying out or extending the distribution system great care should be taken in the laying out of the large feeder mains. In this respect a great deal of care and thought should be given to possible future developments of the city. The laying of long lines of 4-in. main should be avoided as they are too easily overloaded and any future development of the section fed by such a main would require the laying of additional mains. Much expense of this kind could be avoided by a little foresight in regard to the size of mains. This matter of too small mains had been very forcefully impressed upon me within the past year of two, as I have had to take up 5,000 ft. of 4-in. main and replace it with larger main because it was impossible for the 4-in. main to deliver the amount of water required. In Waxahachie we have a 220,000 gal. standpipe about 1 2/3 miles from the pump station. The 4-in. main above referred to led to this standpipe. Before laying the larger main, whenever, for any reason, the pump station was shut down, the water could not flow back through the main fast enough to supply the lower part of the city. Under such a condition the standpipe was of no benefit as a storage tank or pumping cushion and we were practically operating under the direct pressure system. Since that time, larger mains have been put in and we have erected a 250,000 gal. elevated tank 4,500 ft. from the pump station.

DU PONT SELLS HOPEWELL, VA., WATER WORKS

The water works at Hopewell, Virginia, which during the war supplied the great munitions plant of E. I. du Pont de Nemours & Company and adjacent villages, has been sold by the Du Pont Chemical Company to the Industrial Service Corporation of Virginia. The transfer includes electric and steam pumping stations, filtration plant, boiler plant, transmission lines, etc. The new corporation took over the operation of the plant November 1st. The plant has a capacity of approximately 30,000,000 gals. per day which will enable it amply to serve the community and take care of considerable expansion.

J. F. Muhlig is the general manager and operating head of the new corporation, with headquarters at Hopewell, Virginia.

The sale of this water works marks another step in the work of the Du Pont Chemical Company in turning over the property of the former munitions works to peacetime uses. Recently the company gave title to the last of its houses in one of the large villages there. The transfer consisted of 73 dwellings and was the largest housing transaction ever made in the vicinity. Since the campaign was started to turn Hopewell and vicinity over to permanent industrial development, 20 firms have located there.

NEW METHOD OF FIRING T. N. T. IN ELIMINATING MOSQUITO BREEDING PLACES

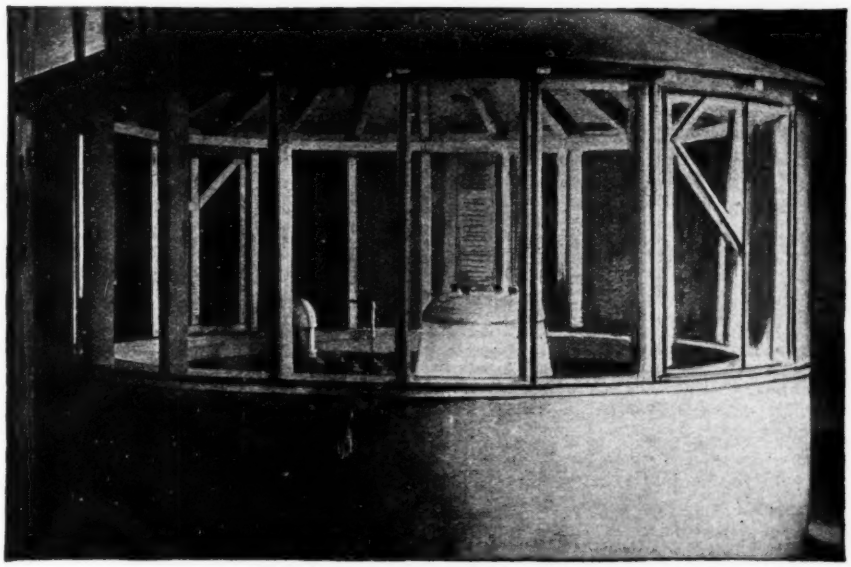
A new method of firing T. N. T. in propagated ditch blasting, which greatly reduces labor costs and saves time, has been evolved by the Mississippi State Board of Health at Greenwood, Miss. It was planned to blast deeper the Walker's Lake Canal to eliminate sources of mosquito breeding.

In describing the new method J. Lyell Clarke, Sanitary Engineer of the Board, says:

Work on the canal was begun in May, was checked on account of the high water, and again discontinued when attempt was made to fire T. N. T. in water by priming each charge with an electric cap connected in series—the usual method.

Owing to the leakage of the electric current through water this method proved a failure, caused misfires and resulted in a labor cost almost prohibitive.

T. N. T. being very insensitive, will not explode by the propagated method, so in an effort to reduce the two main items of cost of ditch blasting, which are labor and caps, a new method has been evolved. Tests were made wherein ¼ lb. charges of 50 per cent straight dynamite were used in lieu of electric caps. Knowing that concussion from the explosion of one



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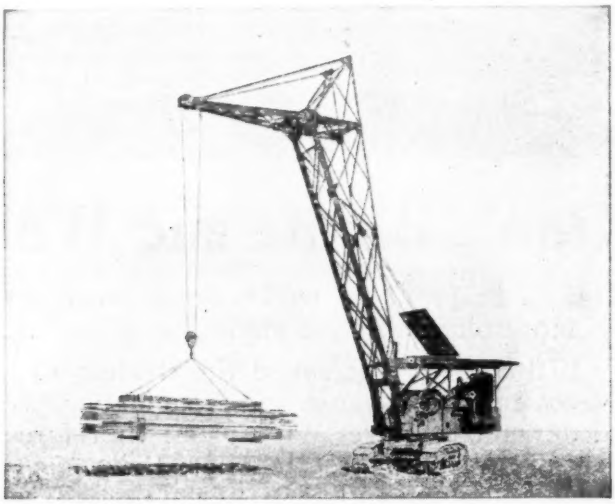
primed charge placed in the center of a line of charges of ¼ lbs. of dynamite, spaced at intervals of 18 ins., would be transmitted throughout the entire line and cause almost simultaneous combustion, it was thought that the explosion of the top charges of dynamite would in turn detonate the large charges of the more insensitive T. N. T. placed beneath it. This it did. The top charges of dynamite exploded the T. N. T. more completely than did the electric caps, shattered the top soil and lifted it well back, gave the T. N. T. an opportunity to heave out the bottom strata in good form, and in addition thereto eliminated the cost of priming each hole, the cost of connecting the caps in series, and the cost of re-

NEW GOOSE-NECK CRANE BOOM

In adapting a P & H 206 Crane of the type shown in the accompanying illustration, to the handling of loads such as unit packages of lumber from high piles, it was found that the lengths of lumber interfered with the straight or standard crane boom. To overcome this and eliminate much of the costly labor required to handle lengths of lumber, pipe, etc., the makers, Pawling & Harnischfeger Co., of Milwaukee, developed the Goose-Neck boom. As the illustration shows, the boom may be lifted almost straight up without having the load interfere. In other respects this boom is like the standard design and attaches to the gasoline-



NEW GOOSE-NECK BOOM, ON P. & H. 206 GASOLINE DRIVEN, CORDUROY TRACTION CRANE, FOR HANDLING LOADS WHICH INTERFERE WITH STANDARD STRAIGHT BOOM. LOAD SHOWN IS 18-FT.x6-FT.x31-INS. AND WEIGHS 3 TONS.

shooting misfires. Only one cap was required to set off one hundred charges. The resulting ditch was wider, larger and more uniform than that constructed with the T. N. T. detonated by an electric cap placed in each charge; besides, the work was speeded up about 200 per cent.

The cost of blasting a ditch 10 ft. wide at top, 3 ft. wide at bottom and 4 ft. deep with charges of 1¼ lbs. of T. N. T. (or Picric Acid) detonated with ¼ lb. charges of 50 per cent straight dynamite spaced 18 ins. apart, is approximately $750 per mile, or 14 cts. per cu. yd. of earth removed. Six laborers under average swamp conditions can blast one mile of ditch in one week.

driven corduroy-traction machine in a similar manner.

The first plant (a furniture factory) using the Goose-Neck boom on a P & H "206" operated it for handling lumber in aisle-ways 18 ft. wide, taking lumber in unit packages off 20 ft. piles and placing on wagons or trailers spotted in the aisle-ways. Hardwood at 4 lbs. per sq. ft. was handled at the rate of 1,500 sq. ft. per trip. The amount handled per day varied and was limited by the auxiliary equipment—trucks, wagons, trailers—required to carry the lumber to stock, or to the cut-up room or for delivery as the case might be. The company using this "206" crane with new Goose-Neck boom will require only 10 laborers instead of 25 previously used, making a labor saving of $60 per day.

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Construction News and Equipment

SUBGRADE WORK ON ILLINOIS HIGHWAYS

(Editor's Note:—Subgrade problems have been much discussed during the past two years and these discussions have influenced practice, of course. The present article describes subgrading work on Illinois highways as outlined in the Manual on Road Construction recently prepared by B. H. Piepmeier, Engineer of Construction, Illinois Division of Highways, Springfield, Ill.)

Subgrade.—A uniform, well compacted, properly drained subgrade has perhaps more to do with the successful completion and life of a pavement than most any other factor. Regardless of the type of wearing surface constructed, the subgrade must necessarily transmit the loads from the pavement to the earth. The subgrade should be recognized as that portion of the road from shoulder to shoulder of the graded roadway. It should be shaped and crowned to drain the water readily to the side ditches and should be as nearly uniform in character as is possible to make it with practical methods. In general, the subgrade that is made by the use of teams or tractors requires very little rolling to secure sufficient consolidation for the pavement. The frequent use of a road drag or planer will usually leave a subgrade in condition suitable for final finishing and placing of the pavement. Where a slight amount of material is moved in the final shaping of the subgrade, a light tandem roller will iron out the surface in a manner that prepares it satisfactorily for the pavement. Special care should be taken to get the subgrade thoroughly compacted immediately under the side forms and for a distance of at least 1 ft. outside. The subgrade beneath the forms must support the load that is applied to the forms and prevent settlement.

Scarifying and Shaping.—After the rough grading has been done, a subgrader or scarifier operated in connection with a power roller may be used to advantage. In some instances light scarifiers are used and pulled by independent power. In either case it is advisable to scarify the entire surface to a depth of at least 2 ins. below the finished subgrade. The pulverized material may then be uniformly spread over the surface to the desired depth and the surface to the desired depth and the surface rolled lightly to bring it to true grade. There are a number of subgrading machines which may be used after the surface has been scarified or loosened. These machines operate on the side forms and trim the subgrade true to the cross section shown on the plans. After the subgrade has been prepared for the pavement, it should not be rutted by trucks or wagons or compacted in such a way that it will not be uniform in character.

Wetting Subgrade.—When trucks are employed very little water should be used for wetting the subgrade in advance of placing the concrete as water will cause some mud to get into the concrete. Under normal conditions and especially where materials are delivered by industrial equipment, the best results are obtained when the subgrade is soaked with water the day before the concrete is placed. This method is much to be preferred and should be used whenever possible. The purpose of wetting the subgrade is to prevent the earth from absorbing an excessive amount of moisture from the concrete during the setting process and to allow the over-compacted earth in the subgrade to swell and obtain its normal condition before the pavement is laid.

Rolling Subgrade.—It is necessary that some form of roller be used in the preparation of the subgrade for the pavement. Under normal conditions the light 3-ton tandem roller will prove entirely satisfactory for this purpose. However, the ordinary 3 to 5-ton horse roller pulled by a light caterpillar tractor engine will also meet the requirements of the specifications and prove to be satisfactory. In some instances the 10-ton, 3-wheeled roller will be used, in which case it should go over the subgrade but once as it is very easy to over-compact portions of the roadbed. In such case the subgrade should always be soaked 12 hrs. or more before the concrete is placed. In general, the use of the 3-wheeled heavy type roller for this purpose should be discouraged. Where there are but a few inches of loose

material to be compacted, a home-made concrete roller or a hand roller may prove to be sufficient to iron out the subgrade preparatory to the construction of the pavement. In no case should the heavy 3-wheeled rollers be used after the soil has been saturated with water as it will over-compact the earth and cause trouble in the swelling of the subgrade after the pavement is placed. The heavy rollers and traction engines are especially desirable for compacting large fills during the process of construction. The 3-wheeled, 10-ton rollers will locate the soft spots in the fill and assist in compacting the loose material and thereby reduce the settlement to a minimum. When fills are built up in horizontal layers of approximately 18 ins. by the use of wheel scrapers, slips or dump wagons, there is usually no advantage in rolling the fills during the process of construction.

Unrolled Subgrade.—In case the subgrade has been prepared for a distance of several hundred feet in advance of the mixer and there should be a heavy rain causing an undue swelling of the subgrade, no attempt should be made to roll in advance of the mixer or of concrete that is being deposited. In this case the use of a subgrading machine or other means of trimming the subgrade true to cross section before the concrete is deposited is sufficient. The subgrade is in an ideal condition for the pavement after a rain or after it has become thoroughly saturated by means of sprinkling as this will cause the earth to swell and assume its natural condition. The principal object in the preparation of a subgrade is to secure uniformity throughout. Should low places exist they may be filled with earth providing they are compacted the same as the remainder of the roads.

Driving on Subgrade.—There is no objection to motor trucks being driven over the subgrade provided they are not loaded to such an extent that the subgrade is rutted or depressed out of shape. When trucks are used for dumping directly into the mixer they should cover the entire surface of the subgrade in order to compact it more uniformly throughout its full width. Narrow steel tires or teams turning or backing on the subgrade shall not be allowed. When trucks are used for the delivery of batches direct to the mixer considerable time will be saved by utilizing a turn table which may be placed on the subgrade a few hundred feet in advance of the paving mixer. Frequent backing and turning on the subgrade often causes large ruts. This should be avoided wherever possible. There are a few truck bodies that are built so as to dump at the side thereby permitting material to be dumped directly into the skip of the mixer before the truck is turned around. This method permits the trucks to turn when empty. In this case turning on the subgrade is not nearly so objectionable.

Porous Material for Subgrade.—When the subgrade is poorly drained it may often appear to be advantageous to roll in a layer of gravel, stone or cinders before placing the pavement thereon. Generally there is no objection to this method of obtaining a suitable subgrade, but in such instances the porous material beneath the pavement should be carefully drained or it will act as a reservoir for water and thereby result in additional damage to the pavement.

Tiling Subgrade.—If an exceptionally wet subsoil is encountered, it may be remedied by intercepting the flow of underground water by the installation of 4 or 6-in. tile drains. Such tile should be placed from 2½ to 3 ft. in depth and the trench backfilled with porous material. A single line of tile down the center or along the upper side of the pavement with lateral drains at various intervals along the road will usually prove sufficient to drain out the surplus underground water. When two lines of tile are used, they should ordinarily be placed beneath the edges of the pavement to a depth of 2 to 3 ft. and the trench backfilled with porous material. In general a 6-in. tile is a desirable size to use for the draining of the subsoil.

Oiling Subgrade.—After the subgrade has been prepared it may be treated advantageously with road oil. The oil will keep down the dust and prevent the formation of ruts and mud during rainy weather. It will make possible the use of light trucks much sooner after a rain and will eliminate the necessity of wetting down the subgrade prior to the placing of the concrete. For construction purposes the subgrade may be oiled for a width of 15 ft. This would enable trucks to follow the oiled portion of the road in the delivery of materials. If the pavement is to secure the full benefit of the oil the subgrade should be oiled to the full width of 18 ft. The oil should be applied as early in the spring as conditions will permit and when the road is free from dust and loose material. It should be applied at the rate of ½ gal. per sq. yd. in two equal applications. The cost

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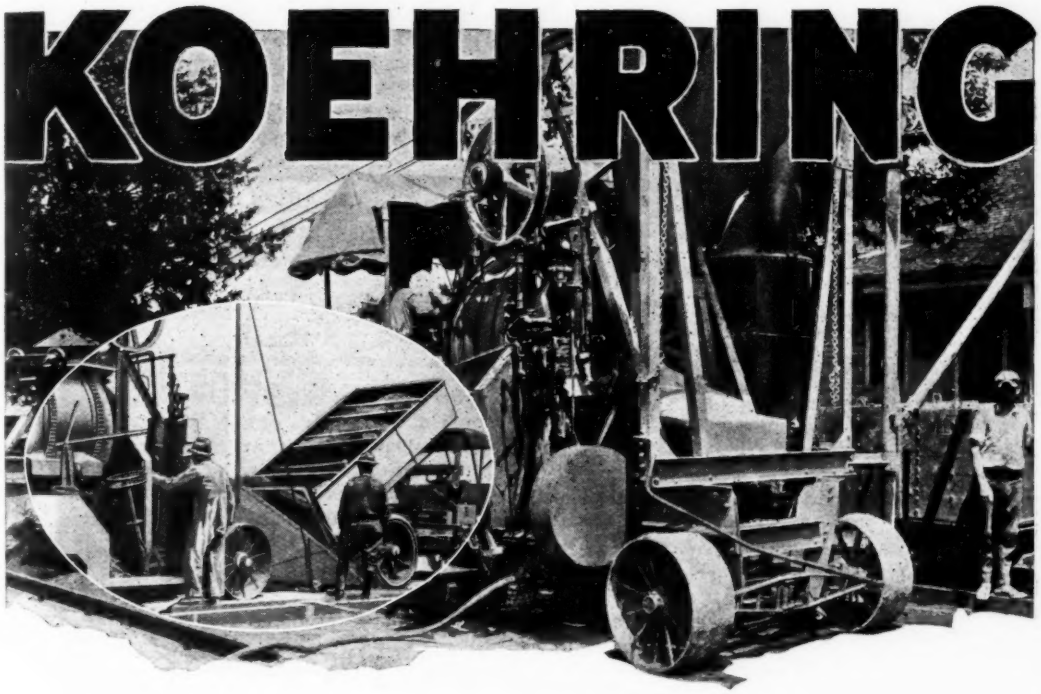

Look under the drum!

IF it is a Koehring mixer, you will see that the heavy drum is supported by drum rollers, constructed on freight car truck principle. The drum rollers do not turn on a fixed axle, which under the down thrust of heavy drums soon must wear flat on the top side and set up pounding vibrations throughout the mixer. No—the rollers which support the Koehring drums are fixed to shafts which turn in big bearings easily accessible on the main frame! There's a simple, accessible, easily lubricated, long-life construction, right there at a point of greatest strain and wear. But it is only one of the better construction features which make Koehring the *Heavy* Duty Mixer.

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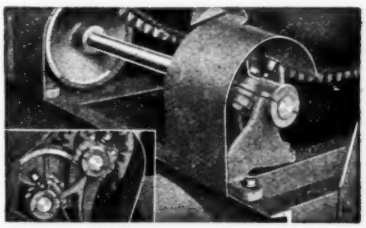
Construction Mixer: 10, 14, 21, 28 cu. ft. mixed concrete, steam and gasoline, power charging skip, batch hopper.

Dandie Light Mixer: 4 and 7 cu. ft. mixed concrete, low charging platform, power charging skip, light duty hoist.

Write for Bulletin P-10.



The above shows the heavy brackets, mounted on the main frame on which are mounted the extra big bearings in which turn the drum roller shafts. Notice that the bearings are at an angle which brings the load on the full face of bearing. These bearings are extraordinarily long, and easily accessible for lubrication or re-babbitting.

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will vary but may be estimated at $300 to $600 per mile of road.

The subgrade that has been thoroughly saturated with oil will resist the raising of subsoil water by capillary attraction and will prevent surface water from softening the subsoil immediately beneath the slab, thereby resulting in additional stability to the pavement.

Frozen Subgrade.—Mixed concrete should not be deposited upon a frozen subgrade for the reason that the frost will be drawn from the subgrade, thus lowering the temperature of the concrete below 40° F. and preventing it from obtaining its proper set. When there is but a small amount of road to be completed during the freezing weather the subgrade may be protected from frost by a covering of straw, which shall be removed immediately in advance of the depositing of the concrete.

Materials on Subgrade.—After the subgrade has been prepared, no materials shall be dumped upon it without the consent of the Chief Highway Engineer. Aggregates may. however, be dumped upon the subgrade or at the sides of the road at intervals of not less than 400 ft. provided the material is placed in large piles and not spread out over the subgrade or shoulders. When material is dumped in this way it should be piled at least three dumps high to prevent spreading and to avoid a surplus of earth being picked up when it is rehandled.

Backfilling Trenches and Bridge Abutments.—When it is necessary to backfill a trench or the space adjacent to a bridge abutment, special effort should be made thoroughly to compact the earth. Numerous pavement failures and bridge failures are traceable directly to negligence in this important operation. The backfill must be made in horizontal layers of not to exceed 1 ft. and each layer thoroughly compacted by means of rolling or hand-tamping until the entire fill is completed. In trench work it is frequently possible to fill the trench with water and make all backfills by dumping material directly into the water; much better results will be obtained in this way, as the fill will settle very little. When backfilling bridge abutments or walls, surplus water should be pumped out before the backfill is made. If this is not done the fill will be softened to such an extent that a fluid pressure will be created that far exceeds the pressure for which the abutment or wall was designed and serious cracking or failure will be the inevitable result. Care should always be taken in backfilling around abutments and wings. All excavated space in front of wings and abutments should be filled simultaneously with the backfill. If this is not done, failure is likely to occur. Do not permit, under any conditions, the puddling of backfills for abutments or the dropping of earth from a great height from drag line buckets or other excavating machinery.

STEEL ROAD FORMS WIDELY USED

A list of the more prominent users of Heltzel steel forms on road construction contains the names of about one hundred of the leading highway contractors and some of the more active of the state and county highway departments. These forms are giving universal satisfaction because of their simplicity, dependability and durability.

The George T. Wilhelm Co. of Helena, Ark., is using 7,000 ft. of the forms and expects, from experience to date, that the forms will last another five years. Depreciation records show almost a negligible amount to be written off against these forms. R. G. Collins, Jr., Contracting Engineer, Cumberland, Md., used the light section on work for the Maryland State Roads Commission, with hand finishing. He used the heavy section on work for the Delaware State Highway Commission, with a finishing machine. He found the forms easy to erect and each section having a bearing on three good pedestals stands up well under the finishing machine. Alan Jay Parrish, general contractor, Paris, Ill., used Heltzel forms on a 29-mile contract of State and Federal Aid Road. He had no form troubles and was complimented by the inspection engineers of the State on having the best line and grade in the State. Heltzel forms were used by the Illinois State Highway Department on the day labor construction on the Lincoln Highway at Frankfort, Ill., as described in the October issue of Municipal and County Engineering.

The Maloney Paving Co., Charlottesville, Va., has standardized on Heltzel forms after considerable experience with other types and assigns six reasons for preferring these forms: (1) Simplicity of adjusting to line and grade, meaning money saved in time and labor required to set them. (2) Fewer parts to get out of order, meaning longer life and less upkeep. (3) More easily cleaned, having fewer places for cement adhesion. (4)

Ease of removing any section along the line, which is often desirable, and to replace it again without in any way disturbing adjoining sections. (5) More readily set to a curb line. (6) Much easier to remove after work is set up.

ENGINE BOOKLETS

Oil Engines and Stationary Steam Engines.—These two booklets are two of many pieces of educational literature on machinery, published by the Vacuum Oil Co., 61 Broadway, New York City, pertaining to construction, operation and lubrication. These booklets have wide circulation and are used as text books by many of the larger colleges and technical schools throughout the United States. Those interested may obtain copies free for the asking.

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ROADS AND STREETS.

Ala., Ashland—Stanley & Singer Constr. Co. awarded contract to constr. 18 miles of road in Clay Co. connecting towns of Ashland and Goodwater, at $159,098.

Ala., Mobile—Toulmin & Son, Toulminville, awarded contract for hard surface Coden and 5 mile Clubhouse roads, at $52,114.

Little Rock, Ark.—Moreno-Burkham Constr. Co., So. Trust Bldg., awarded contract to constr. 10,000 cu. yds. grading; 14,700 lin. ft. curb and gutter; 24,000 sq. yds. sheet asph. on 5-in. conc. base, etc., $120,000 available.

Cal., El Centro—Los Angeles Paving Co., 2900 Santa Fe Ave., Los Angeles, awarded contract for paving 7:5 miles Brawley-Calipatria county road, 16 ft. wide with Willite, at $145,113.

Cal. Los Angeles—W. D. McCray, 424 Am. Bank Bldg., awarded contr. at $74,400 for paving Kaskell and other streets—abt. 1.38 miles, LaCanada, in Rd. Imp. Dist. 1918, with 5-in. cem. conc. at $74,400.

Cal., Sacramento—Following contracts let: Stanislaus Co., asph. surfacing from pt. near Ceres to Tuolumne River brdg. of 1.89 mi. to Standard Paving Co., Modesto, at $14,154; Kern Co. asph. surfacing of 10 mi. hwy. so. of Bakersfield to Southwest Paving Co., Los Angeles, at $47,953; San Luis Obispo Co., grading 10 mi. hwy., 6 miles no. from San Simeon to northerly boundary, to Blake & Heany, Oakland, at $161,712; R. T. Shea, Riverside, awarded contract for paving 15.74 miles asph. macadam road, San Bernardino Co. at about $226,212.

Cal., Sacramento—State Hwy. Comn., let contract to Hopper & Son, Oakland, for constr. of highway mach. and repair shops to be located at 34th and R Streets, at $57,667; Northern Calif. Constr. Co. awarded contr. for work in Tuolumne and Lassen Cos.; 1st for paving 9.4 mi. hwy. from Knights Ferry to point 1 mi. east of Keystone at $129,300; the other grading on outskirts of town of Susanville, at $3,309.

Cal., Sacramento—Healy-Tibbits Constr. Co., San Francisco, awarded contract for grading 9.29 miles road on Black Point cut-off in Sonoma Co. from Fairville to easterly boundary, at $77.404; Riley & Peterson, Oakland, awarded contr. for resurfacing 2.8 mi. bet. Fuuerton and northern boundary of Orange Co., at $54,494.

Cal., Sacramento—Hugh Crummey, Oakland, awarded contract for asph. surfacing of 4.3 mi. hwy. from Perry to Morgan, Santa Clara Co., at $41,830; J. A. Costell, Jr., San Francisco, contr. for resurfacing and repairing 4.26 mi. highway from Delhi to northern boundary of Merced Co., at $30,780; also contr. for asph. surfacing of 6.04 mi. hwy. from southerly bound., Stanislaus Co. to Ceres, at $49.176.

Cal., San Diego—Warren Constr. Co., Portland, Ore., awarded contract for paving Chatsworth

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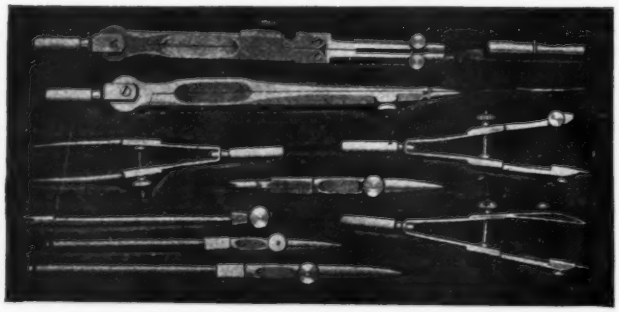

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Cal., San Diego—Geo. H. Oswald, Los Angeles, awarded contract for constr. of 10.7 miles paved road bet. Holtville and Yuma, at $183,265.

Cal., Turlock—J. A. Costello, Jr., awarded contract to pave portions of six city streets at $80,000.

Cal., Whittier—Fairchild-Gilmore-Wilton Co., Los Angeles, Ry. Bldg., Los Angeles, awarded contract for impvt. of Greenleaf Ave.—Orange Dr. to Bailey St. and from College St. to so. city limits, at $100,-494.

Ga., Savannah—Huton Engrg. & Contracting Co. awarded contract to surface Dale Ave. with sheet asphalt at $80,000.

Ill., Bloomington—Hedges Constr. Co., Chicago, awarded contract for grading 1st sect. Bloomington-Peoria hard road, route 9, sect. 11, at $135,755.

Ia., Clinton—T. Carey & Sons, Clinton, awarded contract for paving 17,370 sq. yds. at $87,179.

Ill., Danville—McCalman Constr. Co. awarded contract for new pavement in S. Main St., at $45,855. Specfs. call for pavement with 6-in. conc. foundation, sand cushion of 1½ ins. and 3-in. brick, with asph. filler.

Ill., Pontiac—C. Upham Odell, Pontiac, awarded contract for paving various roads with bitum. macadam on conc. base, at $55,000.

Ill., W. Frankfort—Cole & Farber, Herrin, Ill., award. contr. for paving various streets, brick and asphalt on conc. base, at $130,000.

Kans., Leavenworth—Jas. Stanton, Leavenworth, awarded contract to construct Proj. No. 94, Fort-to-Fort Rd., at $100,150. This consists of 2.190 miles of road extending from end of brick pavement at Lansing to end of old rock road connecting with Proj. 52 now under construction; Fred M. Clark, Savannah, Mo., awarded contr. for constr. of Proj. 94, consisting of .495 miles in city of Tonganoxie.

Ky., Frankfort—State Hwy. Comn., let following contracts: Dempsey Constr. Co., Knoxville, Tenn., for grading & draining 9 miles of rd., Pike Co., at $246,345; Carey-Reed Constr. Co., Lexington, Ky., award. contract to constr. 7 miles Dixie Hwy. in Madison Co., at $230,111; J. C. Williams, Winchester, Ky., grade and drain 12 miles rd. in Breckinridge Co., at $114,469; J. C. Williams also awarded contr. for grading and draining 7-mile rd. in Hancock Co. at $85,765; R. G. Hill, Tazewell, Tenn., contr. to grade and drain 18-mile rd. Lawrence Co., at $246,114; Costello Bros. & Mays, Knoxville, Tenn., awarded contract to grade and drain 9 miles of road in Union Co., at $36,041.

La., Abbeville—Smith Bros., Alexandria, awarded contract by Vermillion Parish to construct gravel roads (also grade), at $350,000.

La., Alexandria—Smith Bros., local, awarded contract by Rapides Parish to grade and gravel roads here at $100,000.

La., Alexandria—J. B. & W. H. Smith, city, awarded contract for road constr. on Sicily Island, Catahoula parish. Work consists of grading and graveling approx. 70 miles of road. Est. cost about $860,000.

La., Arcadia—Smith Bros., Alexandria, awarded contract by Bienville Parish to grade and gravel roads at $600,000.

La., Coushatta—Smith Bros., Alexandria, awarded contract by Red River Parish to grade and gravel roads at $80,000.

La., Harrisonburg—Smith Bros., Alexandria, awarded contract by Catahoula Parish to grade and gravel roads at $750,000.

La., New Orleans—State Hwy. Dept., let contracts for 25.42 mi. in Terrebonne Parish to A. D. Lambert Constr. Co., Alexandria, at $34,189; 22.35 miles in St. Landry Parish to J. C. Wimberly, New Liberia, at $95,984; 4 mi. in Rapides Parish, to Harvey & Frith, LeCompte, at $15,270.

Mich., Lansing—State Hwy. Dept. awarded following contracts: 0.45 miles brick, Kent Co., to Kent County Rd. Comn., Grand Rapids, at $21,980; 0.64 miles conc. in Kalamazoo Co. to Meredith & McVaugh, Tecumseh, at $26,013; 0.47 mi. rein. conc. Houghton Co. to Houghton Co. Road Comn., Houghton, at about $1,750; 3.5 mi. grading and draining, Charlevoix Co., to Cadwell & Sons, Boyne City, at $21,102; 3.16 miles in Antrim Co., to Antrim Co. Road Comn., Bellaire, at $23,313.

Minn., Duluth—Aaby & Maturim, Chisholm, awarded contract for paving 20 miles on Miller Trunk Hwy. No. 1, at $524.071.

Mo., Kansas City—Following contracts let by city: reconstruct asph. conc. pavement on portion of 22nd St. to Gray Paving & Matl. Co., at $11,094; reconstr. sheet asph., on 13th St. at $7,597; reconstruct bitum. asph. macadam pavement on 49th St. to Hallpin and Boyle, Co., at $3,193, plain conc. pavement on Lydia Ave.—53rd to 54th Sts.—at $4,090, vibrated conc. pavement, alley, at $2,765; plain conc. pavement, Mercier St. to Jas. O'Connor & Son, at $965, plain conc. pave. on Wabash Ave., at $4,375; grading 58th St. to A. Kidinskey, at $4,036; grading Cypress St. to E. F. Clarkson, at $5,224.

N. C., Rocky Mount—Robt. G. Lassiter & Co., Raleigh, N. C., awarded contract to constr. 67,000 sq. yds. paving; bitulithic on conc. base, at $238,-000.

Okla., Muskogee—Allen & Harrison, Oklahoma City, awarded contract for 11 mile road bet. Okmulgee and Beggs, at $372,225.

Okla., Oklahoma City—Allen & Harrison, Oklahoma City, awarded contract for stretch of hwy., 11 miles in length, bet. Okmulgee and Beggs, at $372,225.

Okla., Okmulgee—Tibbetts & Pleasant Constr. Co., city, awarded contract for constr. of Morris Rd., at $181, 722.

Pa., Harrisburg—State Hwy. Dept. awarded following contract for road construction: Armstrong Co., So. Bethlehem Boro. and Mahoning Twp., Route 66, Sec. 1, 15,057 ft. rein. conc., 16, 18 and 24 ft. wide, to L. H. Hileman Constr. Co., New Kensington, Pa., at $144,699; Cameron Co., Emporium Boro. Shippen & Lumber Twps., Route 105, Sec. 1-A, 14,832 ft. one-course rein. conc., 16 ft. wide, to Miller Constr. Co., Punxsutawney, Pa., at $137,696; Erie Co., Wesleyville, Boro. and Mill Crk. Twp. Applications 1639 and 1640, 5,368 ft. rein. conc., to Chas. H. Fry Constr. Co., Erie, Pa., at $50,627; Wyoming Co., Tunkhannock Boro., Wash. and Tunkhannock Twps., Route 241, Sec. 1, 20,924 ft. one-course rein. conc. and Hillside vitr. brk., 18 and 28 ft. wide, to Continental Contracting Co., Baltimore, Md., at $196,407.

Pa., Harrisburg—State Hwy. Dept. awarded contracts for road constr. in Schuylkill and Armstrong Cos. as follows: Armstrong Co., Kiskiminetas Twp., Route 188, Sec. 1, 10,576 ft. one-course rein. conc. and Hillside vitr. brk., 16 ft. wide, to Donald McNeil Co., Pittsburgh, at $99,209; Schuylkill Co., Shenandoah Boro., Route 290, 826 ft. rein. conc., 40 and 52 ft. wide, to A. E. La Roche, Hamburg, Pa., at $29,143.

Pa., Philadelphia—Contracts awarded by Director Craven for paving and repaving work, amounting to approx. $250,000 as follows: Principal awards—asph. paving on Eleanor and Rockland Sts., bet. A and B, to Eastern Paving Co., at $10,289, also Limekiln pike, 66th to 67th Aves., at $7,715, Van-Dyke-Hillman to McGee Sts., $3,870; sect. of Springfield Ave., $6,236; Torresdale Ave. to Union Paving Co., at $62,911; Master St.—10th to Lawrence, Olive Sts. and 21st—Brown to Parrish, to Eastern Paving Co., $28,819; Cambria St.—Germantown to Broad, 12th—Huntington to Cambria, to Union Paving Co., at $39,239; repaving mooth granite blk., Mountain and Watson streets—19th to 20th—at $16,752, to J. J. McHugh; repaving redressed granite blk. on Brandywine St.—15th to 16th Sts., Wallace—18th to 19th Sts. and 27th—Aspen to Poplar Sts. to Eastern Paving Co., at $51,338; Geo. F. Dobbin, award. contract for grading Cobbs Creek Parkway—65th to 59th Sts. and Florence Ave., including Beaumont Ave.—65th to the Parkway, at $156,600.

R. I., Providence—Jno. Bristow, Narragansett Pier, awarded contr. to build 4¾ mi. Rockland-Scituate Rd., at $258,647.

Tex., Crockett—Smith Bros. awarded contract to constr. 13.73 miles 20-ft. sand-clay r d. on Hwy. 21, at $ 125,596.

Tex., Edinburg—W. L. Pearson & Co., Houston, Tex., awarded contract to constr. 34 miles of road from Edinburg, no. to Brooks Co. line; gravel, at $170,000.

Tex., Ft. Worth—H. K. McCollum Constr. Co. awarded contract for bldg. Hicks Rd. extending from N. Ft. Worth to Wise Co. line and the Kuteman cut-off, at $113,325.

Tex., Midland—Womack Constr. Co., Houston, awarded contract to build Bankhead Hwy., east and west, thru 4 counties, 100 miles parallel with Tex. & Pacific Ry. A hard surf. road is to be built and it is estimated that a yr. and 6 mos. will be required to complete the work at a cost of nearly $1,000,000.

Tex., Port Lavaca—Miller Constr. Co. awarded contract by Calhoun Co., to surface, grade and drain 11.37 miles 12-ft. shell road on Hwy. No. 7, at $93,653.

Tenn., Sevierville—Gibson Constr. Co., Knoxville, Tenn., awarded contract to constr. and repair roads, at $300,000.

Va., Portsmouth—R. G. Lassiter, Norfolk, Va., S. Silvester, Portsmouth, Va., and Cunningham & Nelson, Newport News, Va., contract to construct 60,000 ft. curbs and 20,000 yds. pavement; $110,000 available.

W. Va., Webster Springs—Queen Constr. Co., Covington, Va., awarded contract to grade and drain 8.25 miles Webster Springs-Diana Rd.; $150,000 available.

Wis., Janesville—Contracts for road work awarded as follows: J. Cape & Sons, 468 Water St., Racine, at $29,519; Gund-Graham Co., Freeport, Ill., 1½ miles on Racine, Freemont, Clark and Blackhawk Sts., at $45,726. Work consists of paving, curbing, guttering and bldg. walks.

SEWERAGE AND SEWAGE TREATMENT

Ala., Tuscaloosa—Hodgeson & Jones, Montgomery, Ala., awarded contr. to constr. storm sewer system in eastern part of city at $17,390.

Ariz., Tucson—Goodman & Merrill, Tucson, awarded contract to construct sewers in University Manor and 6th St., eastern part of Tucson, at $47,488.

Ariz., Yuma—E. L. Plantico, 4120 Central Ave., Los Angeles, awarded contract for constructing vit. pipe sewer system in Sanitary Sewer Dist. No. 3, Yuma, at $119,319. Tropico Potteries, Inc., Glendale, will furnish the pipe.

Cal., Visalia—Michael Murphy, Berkely, awarded contract for construct. main line and intercepting sewers with Y branches and manholes, at $29,750. Main line sewer will be 5,570 ft. 24-in. cem. pipe and the interceptg. line 3,100 ft. 12-in. and 1,950 ft. 10-in. will be vit. pipe.

Ill., Cary—Logan & Giertz, Elgin, Ill., awarded contract for constr. of sewer system and disposal plant, including manholes, flushtanks, etc., at $23,914. Arthur L. Webster, Wheaton, Cons. Engr.

Ill., Springfield—Jno. T. Walbridge Engrg. Co., Chicago, awarded contract for town branch sewer work at $175,610.

Ill., W. Hammond (R. F. D. from Hammond, Ill.)—J. M. Donahue, Stevens Point, Wis., awarded contract for sewer and water constr. job at $33,000.

Iowa, Denison—J. L. Hansman & Sons, 1640 48th St., Des Moines, award. contract for storm sewers on Wash. Ave., at about $15,000.

Iowa, Newell—Cruse Constr. Co., Spencer, awarded contract for sewer system at $27,646; M. A. Camery, Harlan, awarded contract for disposal plant at $18,375.

Kans., Plainville—Reed & Wheelock, Clay Center, awarded contract for constr. of new sewer system at $46,381.

Mo., Cameron—Myers & Peters Constr. Co., Quincy, Ill., awarded contract to constr. sewers in dist. No. 5, at $27,695.

Mont., Forsyth—Wahl & Ball awarded contr. for line sewer and disposal plant at $561,601.

N. Y., Cobleskill—S. B. Easton, 380 Quail St., Albany, awarded contr. for laying sewers on Elm St. and Washington Ave., $10,647.

N. C., Rocky Mount—L. D. Harper awarded contr. to extend sewer system; 8 and 10-in. terra cotta piping, at $21,394.

N. D., Dickinson—Jas. Kennedy, Fargo, awarded contr. for sewers and water mains at $80,820.

Ore., Baker—Roscoe Neil, LaGrande, Ore., awarded contr. by city of Baker for impvt. of sewer system at $17,838.

Pa., Phila.—Adolph Jaffola, awarded contr. for constr. of main sewer in Ogontz Ave., from 67th to 78th Aves., at $20,000.

Pa., Pittsburgh—Jno. F. Casey Co. awarded contr. for Nine Mile Run sewer at $176,078; Stratton Lane, to Thos. Cronin Co., at $3,759; Nimick Pl. to Cronin Co., at $4,254.

S. D., Canton—Kruse Constr. Co., Spencer, awarded contr. for storm water sewer at $12,500. Approx. 3,905 lin. ft. 24 to 36-in; also 750-ft. 10 to 12-in. catch basin connections.

S. D., Mitchell—Tuttle & Parrett, Mitchell, awarded contr. for trunk sewer in Sewer Dist. No. 6, at $18,781.

S. D., Tyndall—W. B. Carter, Sioux City, awarded contr. for sewer system at $60,000.

Utah, Logan—Fred A. Dahle, awarded contr. for constr. work in Sewer Dist. No. 7 on Logan "Island," at $183.719.

Wis., Madison—Jno. F. Icke, Constr. Engr., Madison, awarded contr. for 12 sludge beds at Sewage Disposal Farm, at $23,950.

Wis., Port Washington—Thos. Ubink & Sons awarded contr. for san. sewer and septic tank, at $50,000.

WATER SUPPLY AND PURIFICATION

Cal., Fullerton—Contracts for water works extensions awarded as follows: Trenching, laying and backfilling for abt. 16 miles of pipe to M. & F. Pipe Line Constr. Co., 534 Douglas Bldg., Los Angeles, at $38 725; 2,400 tons cast iron pipe and fittings to U. S. Cast Iron Pipe & Foundry Co., at $75,191 for pipe and $3,600 for fittings, f. o. b. Birmingham, Ala.; gate valves to Pacific Pipe & Supply Co., $5,208; 44 fire hydrants, Mark-Lally Co., $2,540; service pipe, Mark- Lally Co., $1,196; bronze fittings Jas. Jones Co., $354; lead and lead pipe, Crane Co., $539; J. P. Lippincott Cons. Engr., Los Angeles.

Cal., Whittier—Saunders Bros., Whittier, awarded contr. for drilling new well for water department, at $13 ft. for 26-in. pipe driven 100 ft.; $8.73 ft. for 18-in. pipe., driven 500 ft. and $8 ft. for additional 250 ft.

Ont., Dunnville—Webster Constr. Co. awarded contr. for water mains at $5,800.

Ont., Hamilton—Russell Constr. Co. awarded contr. for repairs to the James St. reservoir, at $14,644.

Ont., London—Contr. for laying cast iron siphons across River Thames let as follows: Ann and St. Patrick Sts. to Webster Constr. Co., London, at $2,000; Dundas and Thames Sts. to Peter Mohan, London, at $3,365; York and Stanley Sts., Peter Mohan, London, at $1,748.

Que., Montreal—General Supply Co., Canada, Ltd., Ottawa, Ont., contr. for a number of 36-in. venturi meter tubes, together with Type M register-indicator-recorders, to be built by the Builders' Iron Foundry, Providence, R. I., for installation in new pumping sta. now under constr. at ft. of Atwater Ave. Station, when complete, will cost approx. $9,000,000.

Ga., Augusta—M. C. Morrison, 112 8th St., Augusta, awarded contr. for constr. of pump house and warehouse, at $5,000.

Ga., Thomasville—Wood-Rucker Constr. Co., 502 Walton Bldg., Atlanta, Ga., awarded contr. to constr. 500,000-gal. capy. water storage conc. reservoir, 80x64x15 ft. deep, at $16,000.

Ill., Aurora—R. P. Kuehne, local, awarded contr. for water extensions, at $28,709.

Ind., Hammond—Ludlow Valve Mfg. Co., Troy, N. Y., awarded contr. for furnishing valves for proposed water works project; L. J. Bejdl, Whiting, award. contr. for hauling pipe, digging trench, laying pipe and doing all of the connecting, calking, testing, etc.

Ky., Nicholasville—George Moynahan, Nicholasville, Ky., awarded contr. for constr. of conc. water tank at pumping station at Jassamine, at $3,395.

Mich., Detroit—Lynchburg Foundry Co., Lynchburg, Va., award. contr. for furnishing 1,500 tons 8-in. cast iron water pipe, at $62,775.

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—Stone Screens
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—Surface Heaters
—Tampers, Road
—Tractors
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—Wire Mesh

Minn., Benson—J. B. Cambin & Kelher Co., Benson, awarded contr. for constr. of water main extensions, at $7,992.

Minn., Duluth—Ingersoll-Rand & Co., Providence Bldg., Duluth, award. contr. for gas pump for water and light dept., at $10,000.

Minn., Hibbing—Phelps, Drake Co., Hibbing, award. contr. for pump house and equipt., at Kittsville, at $21,650.

Minn., Luverne—P. N. Gilham, Luverne, award. contr. for constr. of concrete well at $5,765.

Mo., St. Louis—Jos. E. Nelson & Sons., Chicago, Ill., awarded contrs. by Missouri Pacific R. R. (E. A. Hadley, Chf. Engr.) for 5 pumping Stations and water treating plants to be erected at Alexandria, La.; Annapolis, Mo.; Hoxie, McGehee and Van Buren, Arkansas, at $135,000.

Mo., St. Louis—Henry B. Dawson, St. Louis, award. contr. for constr. conc. cap on top of Homer's Dyke at Low Serv. Pumping Sta., Chain of Rocks, at $13,705.

N. Y., Scarsdale—Beaver Engrg. & Cont. Co., 51 Chambers St., New York City, award. contr. for constr. pipe line extensions, at $96,836.

N. D., Dickinson—Jas. Kennedy, Fargo, award. contr. for water mains and sewers, at $70,820.

N. D., Grand Forks—J. M. Carroll, Grand Forks, award. contr. for 6-in. water main on Maple Ave.—Euclid to Boulevard in Lindsay's Addn.—at $3,200.

Ohio, Sidney—L. I. Stark, Cuyahoga Falls, Ohio, award. contr. for extending water mains, at $40,-030.

Okla., Cordell—E. G. Fiske & Co., 23 Neb. Bldg., Tulsa, Okla., award. contr. to improve water works; install filtr. plant, at $39,538.

Okla., Pryor—Ajax Constr. Co., Lawton, Okla., awarded contract for constr. of electric transmission line and water works, at $28,000.

S. D., Yankton—Ellerman-McLaine Co., Yankton, award. contr. for water main extensions at $3,362. Approx. 3,262 ft. pipe, fire hyds.

Tex., Farmersville—R. G. Buckner & Son., Henderson, awarded contr. for bldg. 1,300 ft. water works dam for city lake. There is approx. 35,000 yds. dirt to be placed in dam, which is to be 100 ft. at base, 20 ft. high and 1,300 ft. long, having 10-ft. finish at top.

Tex., Stamford—W. A. Keene, awarded contr. to complete new plant at $125,000. Machy. purchased.

W. Va., Elkins—City let following contrs. for impvt. of water system: Contr. to Concrete Steel Bridge Co., Clarksburg, W. Va., at $57,135; to furnish and install pumping and filtr. plant; New York Continental Jewel Co., Nutley, N. J., at $18,-100 for filter and piping equipt.; Dravo-Doyle Co., Pittsburgh, Pa., at $9,471, for pumps, motors, elec. equipt. and DeLaval pumps, motors, elec. equipt., etc., Frank Hamer & Co., Elkins, W. Va., at $4,965, for additions to reservoir; Pittsburgh-Des Moines Steel Co., Pittsburgh, at $6,418 to lay water mains; . S. Cast Iron Pipe Co., Pittsburgh, Pa., at $6,739 for hydrants, and Rensselaer Valve Co., Pittsburgh, Pa., for valves; total cost, $1,087.15.

Wis., Milwaukee—Allis-Chalmers Mfg. Co., W. Allis, Milwaukee, award. contr. for pumpg. machy. for Riverside Pump Sta., at $641,500. Work includes erection of one 25,000,000 and two 22,000,000 gal. vert. triple expansion crank and flywheel pump engines.

Wis., Wauwatosa—Wenzel & Henock, 497 27th St., Milwaukee, award. contr. for water mains in various streets, at $1.97 per ft.

Wyo., Greybull—E. Lindstrom, awarded contr. for constr. of impvts. to water works system, which includes tower and tank, at $27,630, 2 and 8-in. pipe, at $69,357.

Prospective Work

ROADS AND STREETS

Ala., Ft. Payne—DeKalb County will constr. 17.76 miles of road bet. Ft. Payne and Collinsville; part of Big Wills Valley road; chart constr., $167,-329.

Ala., Tuscumbia—State Hwy. Dept., Montgomery, plans to constr. 8.6 miles highway bet. Tenn. River and Florence. Est. cost, $192,728.

Cal., Alameda—One million dollars will be expended by Alameda Co. Bd. of Supvrs., for the relief of unemployment and in doing necessary road and other public constr. work. Oakland, Alameda and Berkeley are taking up the question of relief work. Under plans of the county following impvts. will be started: Three wards bldgs. at new Highland Hosp., 14th and Vallecito Pl., $480,000; impvt. of rd. from Niles to Newark, $205,000; new roads, serv. bldg. and employes' bldg., San Leandro Hosp., $150,000; water supply system at San Leandro Hosp., $10,000; repairs to Bay Farm Isl. brdg., $25,-000; to Park St. brdg., Alameda, $5,000 to $6,000.

Cal., Oakland—Street and hwy. impvts. to cost $270,000 will be started soon. Exten. of Skyline Blvd. from Moraga Canyon to Redwood Park, a little more than four miles, will cost $50,000 for grading and $20,000 for paving; Madison, 7th to 12th Sts., Jackson, 7th to 12th, and 10th and 11th Sts., Jefferson to Market, will be repaved at cost of $200,000.

Cal., Sacramento—State Hwy. Comn. will call bids for constr. of two stretches of highway near Los Angeles, within 60 days. Comn. has also approved perm. impvt. of 18-mile stretch of Auburn-Colfax Rd. Approx. cost, $400,000.

Cal., San Diego—Will call for bids latter part of November for paving, curbing, grading and laying lateral sewers in 7 streets: 491,259 sq. ft. Willite or asph. conc., 2 courses, 3½-in., $150,000.

Fla., DeLand—Volusia County will complete road from DeLeon Sprgs to Putnam Co. line, 30 miles; shell or rock covered with asph., $200,000 available.

Fla., Green Cove Sprgs.—$150,000 bonds voted to pave streets, constr. sewers, extend water and light plant. Clay County has sold road bonds to constr. rd. from Green Cove Sprgs. to West Tocol.

Fla., Starke—Bradford County voted $550,000 bonds for constructing roads as follows: Hard surfacing main highway across county from northeast to southwest, known as Jacksonville- Gainesville hwy., $300,000; also lateral roads, $250,000.

Ga., Athens—$100,000 will be expended on impvts. to hwys. within city limits of Athens in immediate future. Section of Danielsville rd., within city limits, will be first highway to receive attention. On this route new conc. brdg. at River street and paving estimates to cost $80,000 will constitute the impvts. Other hwys. that will be improved are the Jefferson and Watkinsville routes.

Ill., Kewanee—L. S. Piepmeier, engr. in charge hard road constr. in this district, reports that contr. for cement work will be let this winter on road bet. Sheffield and Kewanee.

La., Monroe—Morehouse Parish will expend $1,-000,000 in constr. of 135 miles of highways. D. E. Harp, in general charge of work as chrmn.; J. A. Davenport. Secy.

Minn., Detroit—Druar & Milinowski, 504 Globe Bldg., St. Paul, Cons. Engrs., preparing plans for paving to cost about $150,000. Type not yet decided on. E. J. Bestick, City Clk.

Minn., Fergus Falls—Following is contemplated program for constr. of county roads in Ottertail County next year: Grading State Rd. No. 1, 8¾ mi., est., $52,200; grad. St. Rd. No. 28, 12 miles, $54,000; grad. St. Rd. No. 6, Effington Twp., 1 4-5 mi., $7,200; grad. St. Rd. No. 13, town of Scambler, 3½ miles, $19,500; relocate and grad. St. Rd. No. 1, to follow north shore Otter Tail Lake, connect rd. 9, 6 miles; est. cost, $13,000; grad. St. Rd. No. 24, 3¼ mi., includes new bridge across river at east end of Lost Lake. Est. cost, $31,500. Grad. St. Rd. No. 12, S & W 3 mi. toward Underwood; est., $18,000; grad. St. Rd. No. 4, 2 mi.; est., $12,000. Co. Rd. Engr. Dieseth. Wm. Lincoln, Aud.

Minn., St. Paul—C. W. Babcock, State Hwy. Commr., estimates that with Fed. aid this State would have available $11,000,000 for road work to start this fall and continue thru the winter. He has the support of labor and other organizations in his campaign for increased Federal appropriation.

Miss., Jackson—Street paving fever has seized Jackson and if municipal commission can make necessary financial arrangements, large amt. of work will be under way within few months. Petition presented signed by all property owners for paving Minerva St., Capitol to Pearl. Petition now pending asking for paving of Gilespie Pl., signed by all prop. owners, also petition seeking paving of

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling and Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Texas Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Loader and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling and Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling and Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Pullers, Electric.
Mead-Morrison Mfg. Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L. The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossmann, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L. The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling and Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son Co., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

W. Pearl—Gallatin to Minerva. Petition will be in circulation this week asking for paving N. President St., from Capitol to 14th, and it is understood petition will also be circulated asking for paving of Adams St., Capitol to Pearl.

Neb., Omaha—New bids will be received in Dec. and Jan. for impvt. of streets in 15 districts, rejected this summer, and bids advertised for 50 new districts.

N. J., Freehold—Bd. of Freeholders decided to aid to extent of $60,000 per mile toward paving of Ocean Ave., Belmar, First Ave., Crescent Pl., and Wash. blvd., Sea Girt and Main St., Avon.

N. C., Ayden—It is reported that Ayden expects to spend $675,000 on hard surfaced streets. $225,000 bond issue voted and this will be augmented by $450,000 from prop. owners on "assessment plan."

N. C., Greensboro—During November it is expected road contracts will be let for work in Fifth District amounting to bet. $700,000 and $800,000. In addition to the Greensboro-Gibsonville Rd., projs. 555 and 561, roads bet. Yanceyville and Haw River, a distance of abt. 30 miles, will be let. This road will be finished in sand clay. Hwy. bet. Lexington and Yadkin River, about 10 mi. hard surf. will also probably be let. J. D. Waldrop, Chf. Engr. 5th Dist.

N. C., Hickory—In futherance of policy to pave every street leading to main hwy., council has accepted petition asking for hard surf. from 16th Ave. on 17th St. to city limits on Hickory-Lenoir rd. Work will probably be done this fall.

S. D. Aberdeen—Paving program including about $680,000 worth of work, outlined and accepted by city commissioners.

S. C., Darlington—City will pave streets at cost of $150,000. Bids will be asked in about 60 days. Lee, Pennell & Murray, Engrs., Sumter, S. C.

S. C., Hartsville—City will pave streets at cost of $200,000. Bids in 60 days. Lee, Pennell & Murray, Engrs., Sumter, S. C.

S. C., Sumter—Sumter Co. will constr. hard surfaced roads at cost of $500,000. Bids within 60 days. Lee, Pennell & Murray, Engrs, Sumter, S. C.

Tenn., Dandridge—Jefferson Co. court will constr. 25 mile road from Dandridge, via Jefferson City, to Knox Co. line; $155,000.

Tenn., Knoxville—Chf. Engr. McCombs, Hwy. Comn. states that program of road bldg. for state embraces 4,500 miles at cost of $20,000 a mile, or total of $90,000,000. Dept. will complete 150 miles of roads this year. State has income from levy and Fed. Govt. of trifle over $3,500,000 a yr. for the road work.

Tenn., Memphis.—Impvt. Ords., involving outlay by city of $700,000, work to begin Jan. 1, passed on first reading by City Comn. North Parkway is to be extended from Manassas St. to Jackson Ave., at Auction Ave. intersection. Exten. will be 100 ft. wide and will conform to North Parkway in design. Est. cost $76,000; South Third St. is to be widened from Beale Ave. to Calhoun Ave. at intersect. with Rayburn Blvd., from 45 to 66 ft. throughout and paved. Total est. cost of impvt., $234,737; So. 2nd St. is to be widened from 40 to 66 ft. bet. Beale and Calhoun Aves. Est. cost, $376,776.

Tex., Denton—Chf. Engr., U. S. Bureau Public Rds., Washington, D. C., has approved plans for constr. of 8 miles 16-ft. gravel road on Hwy. No. 41, Denton Co. Est. cost, $139,347.77. T. E. Huffman, Co. Engr. Ed. I. Key, Co. Judge.

Tex., Laredo—City will pave streets in business district; voted $150,000 bonds. Leopoldo Villegan, Mayor.

Tex., Montague—Montague Co. will constr. roads to and thru Nacona; $260,000 bonds voted.

Wis., Green Bay—Resolution passed by Brown Co. Bd. of Supvrs. calling for bonding county for $1,800,000 for 40 miles conc. roads to be built in 1922.

SEWERAGE AND SEWAGE TREATMENT

Ark., Piggot—City considering installing sewer and water systems. Plans voting on $80,000 bonds. A. C. Moore, Engr., 1710 Murphy St., Joplin, Mo.

Cal., Venice—Koebig & Koebig, Cons. Engrs., Title Ins. Bldg., Los Angeles, have filed with city trustees report on sewage disp. system for city. Est. cost $336,470. Sys. of septic tanks, screens, settling basins and an outfall into ocean are proposed. Carrying effluent to point where water is 25 ft. deep at low tide would require exten. of one of the piers to the outfall line.

Idaho, Coeur D'Alene—Council passed motion directing city atty. to prepare ord. to install sewer sys. in northern sect. of city from govt. way east to 9th St., and from approx. Foster Ave. to Harrison Ave. City Engr. Wells estimates probable cost at $100,000. If sewer proposition is accepted it is planned to start work this fall to relieve unemployment.

Ill., Belleville—Three ords. passed by City Council providing for constr. of sewers at aggregate est. cost $25,305. Sewers are to be laid in Raab Ave. sewer dist., $17,015; in 48th St. sewer dist., $6,000, 36th St. dist., $2,290.

Ill., Mascoutah—Council passed ord. providing for system of san. sewers. Est. cost, $60,000.

Ia., Denison—Resolution adopted by City Council to constr. system of main storm sewers, manholes and catch basins; abt. 334 lin. ft. 12-in., abt. 780 lin. ft. 18-in., abt. 400 lin. ft. 24-in., abt. 360 lin. ft. 30-in. sewer pipe, 9 catch basins, 12 lin. ft. 18-in. sewer runs, 50 lin. ft. 12-in. sewer runs and 9 street inlets. J. H. Patterson, Mayor. Jacob Johnson, City Clk.

Kans., Oberlin—E. T. Archer Co., Kansas City, Mo., Cons. Engrs., retained by city council to prepare plans and specfs. for sewerage system here.

Kans., Salina—State Bd. of Health have issued notice to Salina authorities that city's sewage must be purified.

Minn., Winona—Plans approved for new Third Sewer Dist., west of Lafayette St., south of Chicago, Mil. R. R. trk., 8½ mi. City Engr. E. E. Chadwick. City Clk., Geo. W. Hoffman. $50,000.

N. J., Union Hill (Weehawken, P. O.) Town contemplates bldg. 2,600 ft. 18-in. vitr. sewer in Hackensack Plank Rd. Abt. $50,000. H. Thourot, 414 Lewis St., engr.

Neb., Omaha—City Council voted in favor of extending Minne Lusa sewer thru air field on North 24th St. for air congress. Est. cost, $210,000.

Ore., Eugene—Ord. passed to build trunk and lateral sewer line 2 miles long to serve southeastern section of Eugene.

S. C., Charlotte—Graham Heights Land Co. (McCoy Moretz, Pres., 10 E. 4th St.), will lay sewer lines in 300-acre site to be developed. G. G. Hubble, engr.

Tenn., Jacksboro—City will install sewer system; voted $65,000 bonds.

Tex., Beaumont—City will expend $250,000 to construct concrete storm sewers.

Va., East Radford—Baldwin Land Co. (W. T. Baldwin, Pres.) will construct sewers in 225-acre site.

Wis., Milwaukee—Will ask bids in December for constr. of sewerage works: 24 aeration tanks, 237-ft. long, 45-ft. wide, 16-ft. deep; 11 sedimentation tanks, 98-ft. diam., 16-ft. deep, and 4 sedimentation tanks, 43-ft. diam., 16-ft. deep and 4 sedimentation tanks; all rein. conc.; also 1440 lin. ft. pipe galleries, 17-ft. wide, 13-ft. high, brk. constr. conduits, piping, sluice gates, valves, meters. Abt. 5,000 tons steel reinf. rods; 62,000 cu. yds. conc.; 80,000 filtrus diffusion plates, 42 meters, cast iron pipe, galv. iron pipe. Plans made. Chf. Engr. T. Chalkey Hatton, 433 Lake Drive, Milwaukee. Est. cost, $5,000,000.

Wis., Ripon—City plans to rebuild present sewage disposal plant, trickling filter type. Abt. $13,000. F. A. Preston, Clk.

WATER SUPPLY AND PURIFICATION

Ala., Gantt—River Falls Power Co., River Falls, Ala., will constr. 2500 h.p. hydro-electric plant on Conecuh River; constr. by owners. Southern Engrg. Corp., Albany, Ga.

Ariz., Casa Grand—City considering reconstr. of water system; new pumping equip., 100,000-gal. steel tank erected on 100-ft. tower and cast iron water mains at $90,000; also elec. light sys., at $30,000.

Ariz., Tucson—City Engr. G. H. Atchley, recommends use of deep well turbines for securing better water supply for city.

Ark., Little Rock—Dixie Power Co., Title Guaranty Bldg., St. Louis, Mo., are preparing to begin survey for hydro-electric development on Buffalo river; 50,000 H.P. Est. cost $6,250,000, Co. Henry A. Allen, Engr., 154 W. Randolph St., Chicago, Ill.

Ont., Chatham—Local Bd. of Health passed mo-

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E Mfg. Co.
Midwest Engine Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling and Harnischfeger.
Sauerman Bros.
Smith Co., T. L. The

Expansion Joint Compound.
The Barrett Co.
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling and Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling and Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machine Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Company.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Diamond T Motor Car Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co., The
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros Co.

Paving Joint Compound.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L. The
Warren Bros. Co.

Pipe Cutters.
W. W. Strickler & Bro.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Pumps.
C. H. & E. Mfg. Co.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Midwest Engine Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

tion urging Water Comn. to give prompt and serious consideration to constr. of chlorinating basin.

Ont., Georgetown—Ratepayers passed $60,000 by-law for exten. of water works system. F. L. Heath, Clk.

Ont., Hamilton—T. S. Morris, Secy. of Town Planning Bd., has recommended that impvts. be made to filtr. basin. A 6-in. water main 500 ft. long will be constructed at early date to supply new gas holder. E. R. Gray, City Engr. Board of Control has instructed City Engr. to submit report on cost of hand labor in constr. of $175,000 Burlington St. water main, as compared with cost of mach. labor.

Ont., Ottawa—City Council contemplates constr. of water mains to cost $165,000, in Westboro District. Plans also being prepared for sewerage system to cost $327,000 connected with Westboro-Ottawa annexation for city. A. F. Macallum, Commr. of Works.

B. C., Prince Rupert—Ratepayers passed by-law authorizing expendt. of $75,000 for extension and impvts. to water works. F. S. Clements, Engr.

B. C., Saanich—Council will proceed with constr. of water works costing $150,000, by Day Labor. Hector Cowper, Clerk.

Que., Three Rivers—City Council plans street impvts. to cost $20,000; also constr. of extensions to water works and sewers to cost $30,000. Z. Lambert, Engr.

Colo., Stratton—Bond issue of $50,000 for constr. of complete water works system voted.

Fla., Green Cove Springs—City will extend water and elec. light plants; constr. sewers, pave streets. $150,000 bonds voted.

Fla., Plant City—Mayor Lee considering installing additional pumping unit at water works.

Fla., W. Palm Beach—West Palm Beach is considering expending approximately $115,000 for impvt. of filtr. plant and other impvts.

Ga., Mt. Airy—W. G. Martin, Leesburg, Ga., and J. R. Herrin, Mt. Airy, will construct 30-ft. dam over Broad River; steel flume 5-ft. diam. and 156-ft. long will conduct water from reservoir to power house equipped with 2 turbo-generators developing 600 H.P.

Ill., Hinsdale—City will lay 6-8 in. cast iron water mains. About $27,000.

Ind., Hammond—City will pass ord. permitting East Chicago & Ind. Harbor Water Co., to erect standpipe in City Hall Pk. Approx. cost, $31,000.

Ky., Georgetown—City will install water and light system; vote in November on $100,000 bonds.

Ky., Nicholasville—City issued $56,000 water works bonds.

La., Cedar Grove—City—Mayor Hendricks—plans installing water works; $300,000 available.

La., Jewella—(R. D. from Shreveport). U. S. Sheet & Window Glass Co. (Walter A. Jones, Pres., Morgantown, W. Va.) will erect rein. conc. reservoir with 1,500,000-gal. storage conc. reservoir with 1,500,000 gal. storage capy.; drill several wells to supply water plant.

Md., Brunswick—City contemplates erecting 3,000,000-gal. capy. conc. construction reservoir; 200x12 ft. deep; built 12 ft. above level of ground. Emery C. Crum, City Engr., Frederick, Md.

Mich., Hamtramck—$90,000 bonds voted here for water main extens.

Minn., Little Falls—City may install filtr. plant in river for water supply. Cons. Engr., L. P. Wolff, 1001 Guardian Life Bldg., St. Paul, has recommended this. A. Johnson, City Clk.

Minn., Morris—Plans under way for iron removal and filtr. plant for city water works. Will also remodel old plant. Geo. Geenty, Mayor.

Mo., Liberty—City will expend $60,000 to improve water works consisting of 235,000-gal. steel standpipe water softening plant; two 500,000-gal. capy. elec. driven low and two 500,000-gal. capy. elec. driven high service pumps. W. E. Barnes, City Engr. E. B. Black, City Clerk.

Mo., St. Louis—West St. Louis Pipe Line Co., St. Louis, subsidiary of W. St. Louis Water & Light Co., organized with J. E. Riley, Treas., to lay 8-mile mains.

Mont., Red Lodge—Petitions being circulated asking for constr. of additional pipe line to augment city water supply. Proposed addition will cost about $75,000 and will necessitate laying 10-in. water main from intake of present 8-in. line on west fork of Rock Crk. to 16th street.

N. J., Califon—Califon Water Co., contemplates laying 8-in. main from reservoir to Philhowers store; 6-in. main on Furry street and then a 4-in. main.

N. J., Garfield—City Council passed ord. providing for bond issue of $135,000 for proposed water plant.

Neb., Omaha—Council has authorized 7 new water main districts. Frank P. Larman, Gen. Mgr. Water Dept.

N. C., Charlotte—City considering bldg. pumping station and overhauling water plant. Abt. $300,000. W. E. Vest, 806 W. Trade St., Engr.

N. C., Charlotte—Graham Heights Land Co., (McCoy Moretz, Pres., 10 E. 4th St.) will lay 10,000 ft. 4 and 6 inch water mains on 300-acre site to be developed. C. G. Hubble, Engr.

N. C., Red Springs—Town will issue $50,000 water and electric light bonds. H. Grantham, Mayor.

N. D., Fargo—Following water main extensions recommended by City Engr., Robert Jacobsen: First Ave., N., N. P. Ave. to 1st Ave. S.; 7th Ave. N. Oak to 1st Sts.; 7th Ave. N.—5th to 3rd Sts.; 3rd Ave. N. Broadway to 5th; 16th St. S.—Front to 6th Ave. S.; 1st Ave. N. Broadway to 5th. Will construct this winter. A. R. Watkins, City Clk.

O., Martins Ferry—The J. N. Chester Engineers, Union Bank Bldg., Pittsburgh, Pa., have been commissioned by city to make investigation and report with view to improving municipal water supply system and electric light plant.

Okla., Crescent—Bonds to amt. of $30,000 voted for laying of pipe lines. W. B. Rollins Co., 209 Ry. Exch. Bldg., Kansas City, Mo., Engrs., Fairland, Okla. Plans being prepared for addition to water works. About $60,000. H. G. Olmstead & Co., 415 Exch. Bldg., Oklahoma City, Engrs.

Okla., Fairland—Plans being prepared for addition to water works. About $60,000. H. G. Olmstead & Co., 415 Oil Exch. Bldg., Okla. City.

Okla., Marlow—City plans to construct 4 miles of mains; 250,000-gal. reservoir, pumps and wells. V. V. Long & Co., Engrs., 1300 Colcord Bldg., Oklahoma City.

Ore., Condon—$63,000 bonds will be issued for water works extensions.

S. D., Watertown—Resolution passed authorizing constr. of water mains from intersect. of 2nd Ave. and 2nd Street S. to corner 7th Ave. S. Brownie Mather, City Clk.

S. D., White Lake—City recently voted $45,000 water works bonds.

Tenn., Knoxville—City will construct pumping plant, sedimentation basins, filtr. plant, storage reservoir on Hale Orchard; lay mains from Williams Creek pumping station to Hale Orchard storage reservoirs.

Tex., Alto—$35,000 water works bonds issued here.

Tex., Ferris—$55,000 will be expended by city for impvt. of water works. E. L. Dalton, Supervising Engr., Dallas.

Tex., Galveston—City considering repairing pumping plant at Alta Loma. Geo. E. Robinson, Commr. Water Wks. & Sewerage, recommends immediate impvts. to plant. Southern Engine & Pump Co. detailed two plans for repair: one involves complete overhauling of two 100-h.p. engines, generators and pumping machinery at cost of $5,000 and replacement of third engine, a 75-h.p. for $8,000 at total cost of $13,000. In alternative offer company offers to deliver 4 complete pumping units, clean out and put in service the fifth well., etc.

Tex., Mission—City will improve water works; $40,000 bonds sold.

Tex., Van Alstyne—$45,000 voted by taxpayers of Van Alstyne for purpose of sewer and water works extensions; $30,000 on sewers and $15,000 for water plant.

Va., Galax—Town will expend $45,000 to constr. water works; $500,000 gal. capy.; will erect brick and conc. bldg.; install centrif. pumps, motors, filter equip. 8-in. mains and valves.

Va., Petersburg—Va. Ry & Power Co., Richmond, Va., will build hydro-electric plant; stone and conc. constr. $100,000.

Wash., Walla Walla—City will sell bonds $500,000 to provide funds for proposed water system.

W. Va., Huntington—Chesapeake & Ohio Ry Co., (C. W. Richmond, Chf. Engr., Richmond) plans installing reservoir for shops on land adjacent to Rotary Park; considering utilizing surplus water for park lake.

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The Texas Co.
Uvalde Asphalt Paving Co.
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Austin-Western Road Machinery Co., The

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Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

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Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
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Stewart, W. H.

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Integrity Chemical Co.

Special Castings.
The Flower Company.
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Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

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Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
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Walter H. Flood.
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Kirschbraun, Lester.
Van Trump, Isaac.

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Traction Engines (Oil or Kerosene).
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Barrett Co., The
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Water Purification.
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

Water Softener.
The Refinite Co.

Water Works Supplies and Equipment.
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Mueller Mfg. Co.
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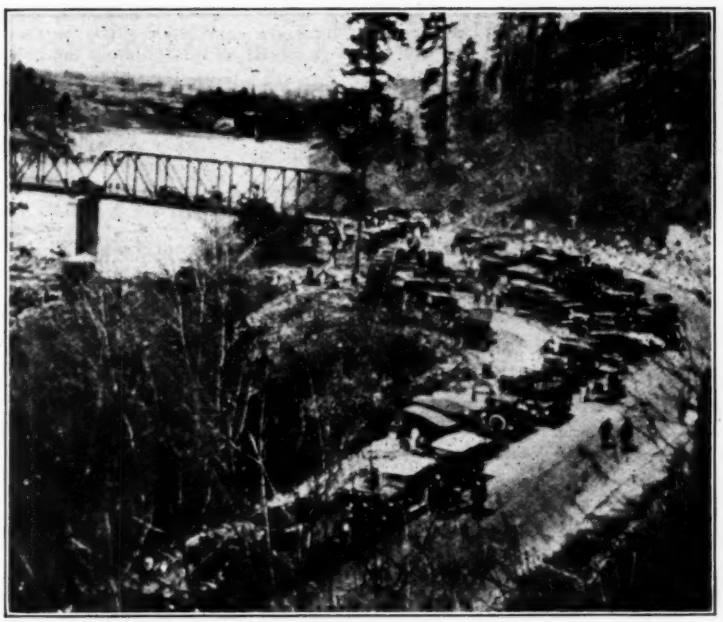

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